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The Journal of Electricity

An Illustrated Review of the Industrial Applications of Electricity, Gas and Power.

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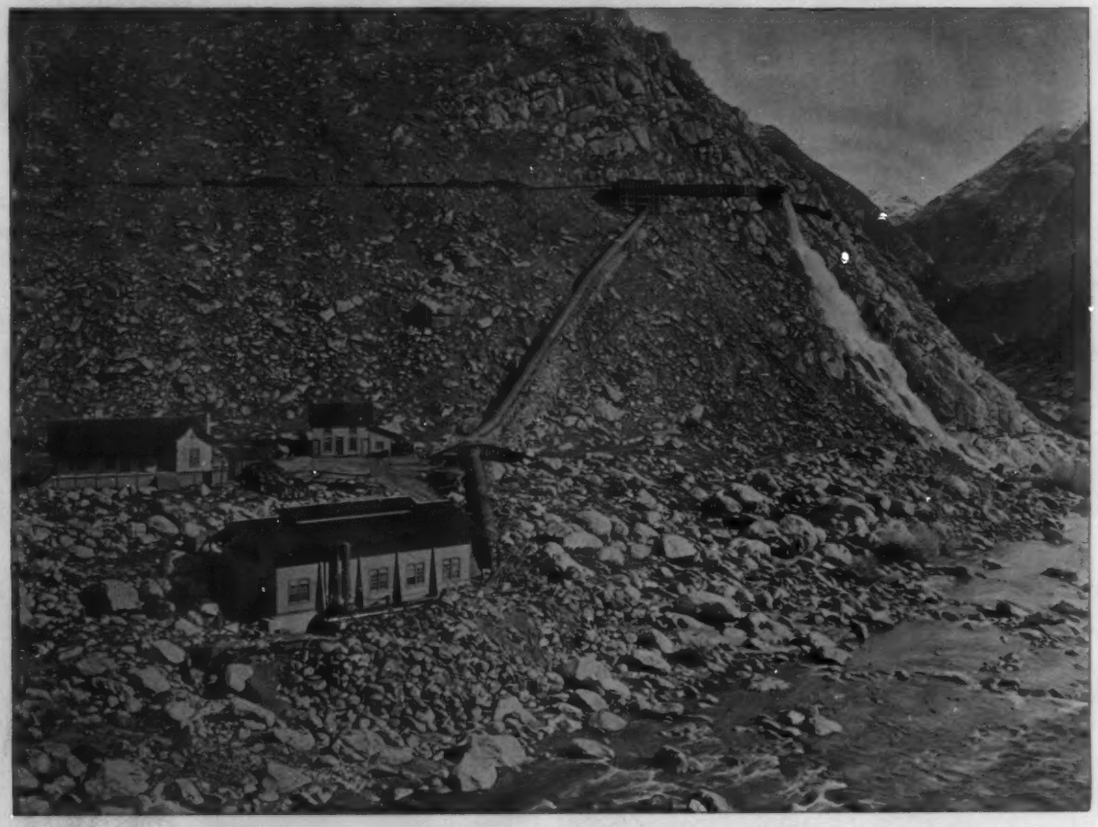
The Journal of Electricity

VOL. IV. AUGUST, 1897. No. 5

The Bakersfield Transmission.

The announcement that a trip to Bakersfield and an examination of the electrical transmission plant of the Power Development Company, which is there located, is to be undertaken, brings forth from those who have been there in summer uncomforting tales of a particularly torrid climate. The habitual story teller will drag from his grab bag of drivelling reminiscences, well worn yarns of the time he spent in Yuma and tell you that in Bakersfield too, hens do not set on eggs to hatch them, but to keep them from baking, while, if he be an engineer, he will solemnly vouch for the truth of tests he has made of steam boilers in Bakersfield from which it was conclusively proven that with picked coal and trained firemen, it was easily possible to attain an evaporation of 30 pounds of water from and at 208 degrees F. in a water tube boiler with a consumption of three-eighths of a pound of coal, provided the top of the boiler was exposed to the sun. Another story teller will probably relate that the Bakersfieldian on reaching Hades, found blankets to be of no comfort until after he had stimulated his circulation with a horn of tobasco. Then too, the bleak granites of the great canyon of the Kern river, it is said, harbor centipedes and scorpions and rattle snakes in every crevass. and so unalluring were the prospects extended that it must be confessed the journey was undertaken with a mild sort of abandon-hope-all-who-enter enthusiasm.



AT THE GENERATING STATION OF THE POWER DEVELOPMENT COMPANY.

None of these stories are of course any more true than was the equally solemn assertion that in Kern county thermometers are built horizontally because it is impossible to make them high enough to record the temperature there. In midsummer the weather is hot,

to be sure, but the visitor will not find it unbearable if discretion be used in matters of dress, of exercise and of diet.

Until the completion of the Valley Road into Bakersfield, the best way to reach that city from San Francisco will be to take the Southern Pacific Company's night train leaving at 5 p. m. and scheduled to arrive at Bakersfield at 4.30 a. m., but the schedule is generally a bit of fiction, for the Southern Pacific Company

THE FLUME GRADE AND THE KERN RIVER.

makes no attempt to regain lost time, and the traveler soon becomes convinced that with the S. P. Co. it is, "once late, always late." It is best to start at once for the power house before the sun rises high, always provided, of course, that your train graciously condescends to sanction your arrangement. The roads are good and in about two and one half hours the visitor should be at breakfast at the cosy cottage of the company at the generating station. This is located right at the mouth of the Kern River canyon, where from out the rolling foot hills abruptly rise to an elevation of 1300 feet higher, the wild rugged granites forming the very edge of that portion of the Sierra Nevadas. One marvels at the rockiness of these surroundings and is astonished to learn that the power house site, consisting of a trifle over two acres of ground, cost the electric company ten thousand dollars, and that the clearing of the ground for the power house and buildings cost over $4100 additional.

In countries where water is less prized than in Kern county, the Kern river would be called a creek in summer, for it is but a mountain stream, even though a large one. At times it is torrential and at other portions of the year, neary its entire flow will be diverted into the flume. The bleak rocks carry very little soil between them, hence except in the spring, the mountains are almost totally without verdure of any kind, while high above them great eagles soar continually. Gray squirrels, jack rabbits and cotton tails abound; cayotes and wild cats are occasionally seen, while in a small grove of trees, less than two miles above the power house, deer may be found at any time, but the canyon is a government reservation and the deer remain inviolable. One day a large buck fell into the flume near the point to diversion. He swam down the water way and was swept out over the waste gate near the forebay, meeting death in the fearful plunge of 200 feet over the sharp jagged rocks that form the side of the canyon.

There is neither dam nor ditch at the in-take of the flume. The diversion of water from stream to flume is direct and merely consists of a channel formed by blasting out the boulders. The flume itself is a difficult and hazardous piece of engineering and the troubles attending its constructions were due to the solid granite formation of the mountain, to its almost precipitous sides, its extreme irregularity and to the constant danger of rolling boulders and land slides of disintegrated rock. The completed structure, nevertheless, is a substantial water-way built on very solid foundations and thoroughly shored. All curves have a uniform radius of twenty-five feet and the longest continual straight stretch of flume has a length of 210 feet.

Every precaution has been taken to prevent accident to the flume from rolling boulders and rock slides and even the whole mountain side for a length of 10,000 feet and for an elevation varying up to 1200 feet was gone over by men with crow bars, who rolled down every loose boulder, but the action of elements and the disintegration of the granite by the atmosphere work changes that necessitate constant watchfulness. For hundreds of feet the flume graders were held suspend-

CARRYING DYNAMITE UP THE MOUNTAIN.

ed by ropes from the rocks above while they drilled for blasting, but not a serious accident occurred during the entire work. Some idea of the amount of blasting required will be had when it is known that while the length of the flume is less than 8800 feet, nearly fifteen tons of dynamite were consumed in blasting for the flume grade.

Eternal vigilance is always the best assurance of uninterrupted service in every flume, and in addition to

THE VIRGIN CANYON.

the constant inspection that the water-way of the Power Development Company is subjected to, it is thoroughly equipped with appliances, some new and novel, for further minimizing the possibility of interruption. About 200 feet from the head of the flume is located a trip gate. This device, which is either manual or automatic in its action, consists of a vertical flashboard gate, held in suspension across the flume above the water line by means of an electrically operated trip or trigger device. The gate is faced with narrow removable flashboards so that when closed the flashboards may be easily removed, thus relieving the pressure of water and enabling the gate to be opened by one man. Along the entire length of the outer side of the flume near its bottom, are run two No. 16 soft drawn bare copper wires, forming the circuit supplied with current from ten cells of gravity battery placed in the power house and controlling an iron clad electro-magnet that holds a ten pound sledge hammer in suspension. This magnet is 4½ inches in length and consists of a wrought iron core, having a diameter of 1 1-16 inches, about which is wrapped one-half an inch thickness of No. 22 cotton covered magnet wire. The whole magnet is then sealed in a piece of two-inch iron pipe forming one pole, the core being the other pole, while the face of the sledge hammer constitutes the armature or keeper of the magnet. Normally the gate is held in suspension by a trip lever and the sledge is held in suspension by the electro-magnet, but on the occurrence of the open- or short-circulating of the bare copper flume circuit, the magnet releases the sledge which drops on the trigger actuating the trip that releases the gate which falls and closes the flume. At the same time an alarm of notification is rung in at the power house. The advantages, not to say necessity, of some such controlling contrivance is impressed by the knowledge that a break in the flume if unchecked would cause great damage by washing out foundations and the flume patrol has thus, moreover, instant control over the head gate from all parts of the flume, and even from the power house. To close the trip gate, it is only necessary to either break or short circuit the light bare copper flume wiring.

A SIDE GATE.

At first, it will probably appear that the trip gate equipment introduces an element of unreliability into the system, but the details have been so carefully worked out and the circuits have been so located that accidental actuation seems almost impossible. From the battery the circuit continues through a signal board, giving constant visual indication of the condition of the battery. If the battery is permitted to run down a point of depletion is reached when an alarm will be rung in, but the magnet will, nevertheless, continue to hold the sledge in suspension until the potential applied has been reduced below three volts. From the potential indicator the circuit passes through two ordinary telegraph

AFTER A BLAST.

relays in multiple before going to line. These relays have respectively front and rear secondary contacts, either controlling the alarm circuit, the former being actuated by the short-circuiting of the line and the latter either by its open-circuiting or the weakening of the battery. The inception and installation of the trip gate equipment is due to Mr. C. N. Beal.

Details of the flume construction are subjoined in the appendix hereto. In general, the flume is built of selected coast redwood free from knots and which was

HEAVY WORK AHEAD.

sawed on the ground in order that the timber would not be injured in transportation. The flume is double-lined and contains throughout between each of the board linings, a thickness of heavy P. & B. building paper applied with hot asphaltum at the seams and which alone insures water proofing.

Referring to the general view of the power house, pipe line and canyon on a point of the flume about midway between the forebay and waste gate, is located a water gauge for showing the height of water in the flume. The characters on the gauge are discernible to the naked eye from the power house by day, but at night the gauge is illuminated by incandescent lights, there being a white lamp at each foot mark and the traveling index carrying a blue lamp. The lamps are controlled by a switch placed in the thermometer house—colloquially termed "the weather bureau"—which is at the entrance of the station.

About 200 feet below the trip gate is a sectional trap gate placed at the bottom the flume for draining the flume and for relieving it of such water as may leak through the head trip gate when closed. A short distance further down is located the sand trap, consisting of an adjustable opening in the bottom of the flume at the lower end of a fifty foot section which has its bottom seven inches below that of the rest of the flume. At various points along the flume are located three side gates of usual form, while close by the forebay are a spill way and waste gate as shown in the general view. Equi-distant along the flume are four telephone booths leading to each other and to the power house.

The pipe line has a length of 540 feet with an inside diameter of 66 inches and at very reasonable velocity of flow it has a capacity exceeding 2000 horse-power. It was specially designed to meet existing conditions and an inspection by the writer of its entire length failed to discover a single leak. The pipe after being laid was covered with a heavy coat of P. & B. paint and was then buried in earth well tamped-in with water, which made a solid and substantial bed. This earth filling completely covers the pipe except for about one-sixth of its circumference at the top..

Full specifications showing the detailed construction of the pipe line, receiver and accessory equipments are appended to this article, but it may be stated that attached to the receiver are three cast iron saddles whose outer openings stand at an angle of 45 degrees from the center line of the receiver and to which saddles are attached three goose necks, two of which lead to the water wheel units, the remaining one being provided for a future extension. Each water wheel set is provided with a twenty-inch gate operated direct by an hydraulic cylinder as shown in the illustration on page 95. About midway between the forebay and receiver there is placed in the pipe line a 10 inch by 16 inch man-hole and at the two points of highest elevation in the pipe line are placed air valves which automatically open on emptying the pipe and automatically close on refilling it. As stated, the effective head is approximately 192 feet.

The prime movers consist of two sets of 44-inch Girard water wheels, each set containing two independent

LAYING THE PIPE LINE.

wheels as clearly shown in the illustration appearing on page 91. These wheels are direct connected with each other and with the generators, the exciter for each combination being driven from the governor fly wheel which weighs 6000 pounds. The gates are controlled by hydraulic rams as shown, while the governor, which is about to be described, actuates a similar ram that controls the seven nozzles of each wheel of the two sets and at the same time opens or closes as the case may be, a compensating by-pass valve, the

rear of which is shown in the illustration just beyond the main valve. These wheels run at 257 revolutions per minute and the decided novelty in the water wheel equipment consists in the governor. On page 95 is presented an outline sketch of the Girard governor, the action of which will be understood from the following description, which is here published for the first time:

To the person acquainted with steam engine practice the governor appears to be an ordinary form of shaft governor, but a closer inspection will show that it is in fact a transmitting power dynamometer as well as speed regulator and that the positions assumed by its elements are determined by the load passing through it, as will now be briefly outlined.

Referring to the drawing on page 95, the water wheel shaft A extends for a short distance into the hub of the fly wheel M and is a free fit therein. The fly wheel M is attached by insulated flange coupling direct to generator shaft, and consequently always revolves therewith.

On the water wheel shaft A is keyed the double crank B, having at the extremities of its two arms the crank pins C and C'; links D and D' connect the crank pins to the swing levers E and E' at the pins V and V'. The swing levers E and E' are attached by pins H and H' to the fly wheel M and have at their opposite extremities the adjustable weights F and F'.

Between the levers E and E' are strained the tension springs S and S', whose locations are at equal distance each side of the center line of the shaft A. At T and T' are stops attached to the rim of the fly wheel M to keep levers E and E' from drawing in too close to shaft A, and when revolved the outward throw of the levers due to centrifugal force is limited by the outer end of the levers coming into contact with inner surface of wheel rim, as shown at F" in dotted lines. At L and L' are

WITHIN THE FLUME.

links which, being attached to bell crank levers (not shown in sketch), give longitudinal motion to a slip collar on shaft A and by a system of yoke lever and connecting rods, actuate the balanced valve of an hydraulic cylinder, which in turn opens and closes the nozzles and by pass valve as may be required.

The direction of revolution of the whole is shown by the arrow—and conditions of design and operation are such that levers F & F' are in position shown when maximum load is being transmitted at the predetermined number of revolutions per minute; and when no load is being transmitted they will take positions (as

THE SAW MILL AND LUMBER INCLINE.

shown in sketch for one of them by dotted lines F") with their outer ends at the position of extreme throw. Intermediate positions will correspond to some transmitted load between no load and full load.

To make this more clear let us assume a governor as applied to regulate speed at 200 revolutions per minute and transmit from nothing to 200 h. p. Let the diameter of the circle swept by the pins H and H' be such that its circumference is 12.56 feet, then the force applied in the direction of a tangent to this circle as shown by dotted line x-y must be such that traveling 2512 ft. per min. it shall develop 200 h. p. or 2626 lbs., and as this force is transmitted through the two pins H and H' it must be of such intensity that its resultant in the direction x-y shall be 1313 lbs.—for each swing lever.

Suppose the design is such that the angle between the swing levers H and H' and this tangent x-y, giving the resultant direction of the force, is 30 deg. and that the distance from center of pin H to center of pin V is 7 inches, then 6 inches will be the distance between center of pin V and the force line x-y measured at right angles thereto.

Let the distance from the center of the pin V to the pin attaching link L to lever E be 13¼". Then we have $\frac{1313 \times 6 \text{ in.}}{13.25} = 594.5$ lbs. as being net force which we must have acting radially outward from the above mentioned central point in order that full power may be transmitted through the dynamo-meter; to this must be added also the total initial tension of the two springs S and S' which let us assume as 305½ lbs. Then the total centrifugal force of all the elements swinging about the point H' must be such that, when assumed as concentrated at the centrai point above-mentioned between the sprins S and S', it

shall just equal 594.5 lbs. plus 305.5 lbs. equal to 900 lbs. and this central point will then be traveling, let us say, in a circle 34⅛ inches in diameter, and all parts be in the position shown in the sketch.

Considering now the conditions when the swing levers are thrown to their extreme outward position by centrifugal force, the central point above mentioned will travel, let us say, in a circle of 13 15-16 inch radius, then a weighted swing lever which produced 900 lbs. centrifugal effect in the first case will now at the same number of revolutions per minute, cause a centrifugal force of 1040 lbs.—and the springs S and S' will each be increased in length 3¾ inches.

The springs S and S' are of such design and proportions that when having a fixed load of 305½ pounds, an additional load of 734½ lbs. will cause them to be extended 3¾ inches.

The results thus obtained are then as follows:

First—When all parts are in the positions shown in the figure and revolving at 200 rev. per min., 200 h. p. will be transmitted from shaft A to wheel M.

FALSE WORK FOR A FLUME ARCH.

Second—When revolving at 200 revolutoins per minute and levers H and H' are thrown out to their extreme positions, no power will be transmitted from shaft A to wheel M because in this position of the parts, the spring tensions and the centrifugal force of the swing elements are in balance and no force is transmitted along the swing levers E and E' to the pins H or H'.

Third—As it is impossible for the springs S and S' to be of such proportions that practically equal extensions are produced by equal increments of load, it may be assumed that different positions of the swing levers H and H' between their extreme positions are measures of proportionate loads between no load and full load.

The rams controlling the nozzles and by-pass valves were originally actuated by water from the pipe line, but during certain seasons of the year the water is so gritty as to prevent satisfactory working from cut-

THE FINISHED ARCH.

ting the valves, and to avoid this the rams are now operated by oil under air pressure from the air chamber. Bolted to the base plate at the outer end of the rear side of each wheel set is a combination oil and air pump which is driven by belting and gearing from the main shaft. The ram discharges oil into a tank outside of the station and when the level of oil in this tank covers the orifice of the section of the oil pump, the oil is pumped into the oil receiver, and at other times the pump takes air which is forced into the air chamber.

Except in the matter of the sizes of units the electrical equipment of the power house does not differ materially from that of other transmission plants installed in California by the General Electric Company. The two 450 kilowatt units, which may of course be

THE GRADE AT WATER LEVEL.

run either singly or in synchronism, deliver current to their respective panels on the switchboard where they are connected to either of the two sets of bus bars through their main switches. From the bus bars current is carried to the two transformer panels, consisting merely of main switches and ammeters for each set of transformers. Separate ammeters are provided for each generator, for each bus bar and in the primary of each transformer set, the bus bar ammeters being placed at the top of the switchboard above the exciter panel. On this latter panel are located the usual exciter, ground detector, synchronizing and potential indicating apparatus so fully described in Mr. C. E. Dutcher's article on "Some Details of the Fresno Transmission Plant," appearing in the issue of the Journal of Electricity for April, 1897. Two General Electric multipolar, 125-volt exciters are used, each having a capacity of 17.5 kilowatts, and either being capable of exciting both generators and carrying the entire incandescent load for the generating station and buildings.

INTERIOR OF THE GENERATING STATION.

Dr. Cary T. Hutchinson, of the firm of Sprague, Duncan & Hutchinson of New York, who was selected as the consulting electrical engineer of the Power Development Company, made an exhaustive test of the appratus used before its shipment from Schnectady, and this being the first report by a competent and disinterested engineer on the efficiency and characteristics of this type of transmission apparatus avsalable, is here published in its essential features for the first time. The measurement of the general efficiency included the mechanical power delivered to the exciter, the efficiency of which was found to be eighty per cent. The commercial efficiencies of the generator were found to be as follows:

Full load	94.1 per cent.
Three-quarters load	93 "
One-half load	91.4 "

The generators were tested under full load for ten hours, and the rise in temperature was calculated from the increase in ohmic resistance and direct from thermometer readings. The insulation was measured by the volt meter method and by pplying a potential of 3,000 volts to the fields and 5,000 volts to the armature. The apparent anomoly in the field temperatures as determined by the resistance method, (15 degrees). and by the thermometer reading (24 degrees) is probably due to the thermometer being affected by the heat of the armature. The fields run very cool.

The report shows the heating of the armature to be 47 degrees Centigrade and of the fields, 15 deg. C. as calculated by the increase of resistance method, while the following readings show the rise in temperature above that of the air as recorded by the thermometer direct.

Bearing	17 deg. C.
Collector ring	30 deg. C.
Field coil	24 deg. C.
Leading pole tip	21 deg. C.
Trailing pole tip	23 deg. C.
Binding wires	51 deg. C.
Armature surface	43 deg. C.
Top of iron frame	10 deg. C.
Armature spider	32 deg. C.

The step-up transformer equipment consists of two sets of the General Electric type of air blast transfor-

mers, there being in each set three 160 kilowatt transformers taking the generator sixty cycle three-phase current at a potential of 500 volts and delivering to line a potential of 11,500 volts. The primary and secondary windings of both of these transformers are in

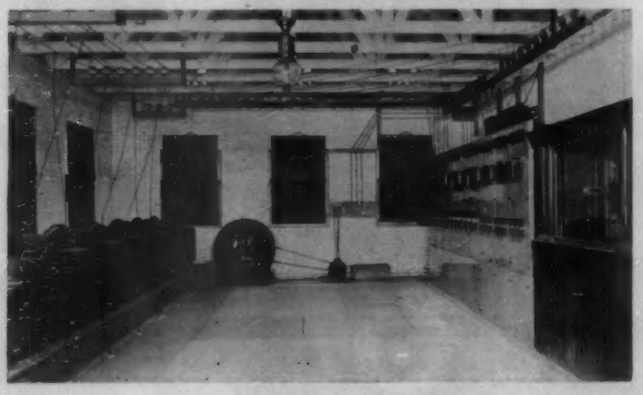
THE SUB-STATION IN BAKERSFIELD.

delta, and a seventh transformer is at hand to use in emergency.

The transformers were submitted to a like exhaustive test which lasted under load for 4½ hours, the temperature being measured by the increase of resistance method.

	160 KW	75 KW.
Primary	33 deg. C. average.	35 deg. C. average.
Secondary ..	32 deg. C. average.	32 deg. C. average.
Iron	22 deg. C. therm.	21 deg. C. therm.
Eff'y full load	97.4 per cent.	96.7 per cent.
" ¾ load ..	97.1 per cent.	96.1 per cent.
" ½ load ..	96.05 per cent.	94.8 per cent.
Eff'y ¼ load ..	92.7 per cent.	93.2 per cent.
" 1-10 lood	84.0 per cent.	83.0 per cent.
Core loss full volts,	3,200 watts average	2,050 watts average.
Magnetizing current,	.52 amperes	.375 amperes.
Power factor no load,	.53	.54
Insulation test ..	20,000 volts.	20,000 volts.

The connections on the high potential boards at the power house and at the sub-station together with the method of effecting local distribution at Bakersfield, form the most interesting departures in the entire



INTERIOR OF THE SUB-STATION.

electrical equipment. The details of the high potential switchboard at the power house are shown in the outline drawing on page 93, while those of the high potential switchboard at the sub-station appear on page 94. Panels A, B and C of the high potential board at the power house are clearly shown in the general view of its interior to consist of three sets of double pole, double throw switches, but the multiple panel, which is to the right of these three panels, is hidden from view by the frame of a generator. This multiple panel, however, merely consists of one set of triple pole single throw switches. All high potential switches used in the installation are of the familiar quick action type of the General Electric Company, having twelve inch breaks.

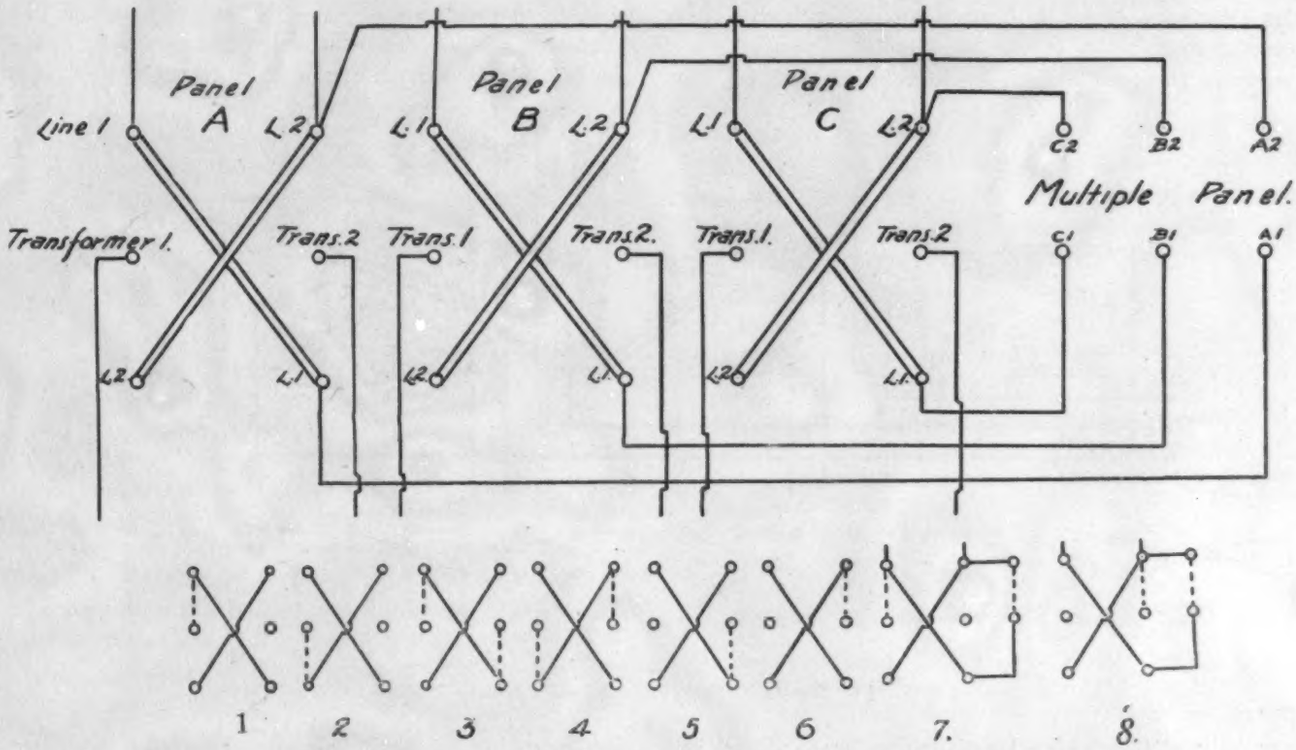
Immediately below the circuit connections of these high potential boards in each of the drawings are shown numbered diagrams that afford the key to the combinations which may be effected. Of course it is understood that in making circuit combinations the switches must be in the same relative position on each of panels A, B and C, which correspond with legs A, B and C of the three-phase circuits. This holds true in

THE HIGH POTENTIAL SWITCHBOARD CABINET.

both the power house and sub-station high potential switchboards, but the latter differs in appearance from the former in that it consists of but three panels, each being a set of triple pole double throw switches. In the generating station the transformer sets are on the switches and lines 1 and 2 are connected to the upper and lower switch contacts as shown in the outline drawing. In the sub-station, however, the lines are connected with the switches. The third line (that connected to the right hand switch of each panel) consists of an extension 10,000-volt circuit that is continued on from the sub-station for a distance of about ten miles beyond Bakersfield as will hereafter be described. This line, known as the Stockdale circuit, together with the two lines from the power house, form three high tension circuits that are connected to the switches of the primary board in the sub-station. The lines from the power house are designated as line 1 and line 2, while the knife clips leading to the sets of step-down transformers are shown as transformer 1 and transformer 2. The connections of the sub-station high tension board are clearly shown in the accompanying drawing.

Reverting to the key of the high tension switchboard connections, the dotted lines appearing thereon show the different switch positions, and the number of the circuit connections, indicates like connections on both high potential switchboards. The various numbered combinations effect switchings as follows:

Combination 1. Transformer Set No. 1 on Line No. 1.
" 2. Transformer Set No. 1 on Line No. 2.
" 3. Transformer Sets No. 1 and 2 on Line No. 1.
" 4. Transformer Sets No. 1 and 2 on Line No. 2.
" 5. Transformer Set No. 2 on Line No. 1.
" 6. Transformer Set No. 2 on Line No. 2.
" 7. Transformer Set No. 1 on Lines Nos. 1 and 2.
" 8. Transformer Set No. 2 on Lines Nos. 1 and 2.
" 9. Stockdale Extension on Line No. 1.
" 10. Stockdale Extension on Line No. 2.



CONNECTIONS OF THE HIGH POTENTIAL BOARD—GENERATING STATION.

Combinations 7 and 8 apply only to the generating station, while combinations 9 and 10 are applicable to the sub-station alone, and the particular criticism that may be applied to the high tension board in the sub-station is that it affords n means of feeding both sets of transformers from one line.

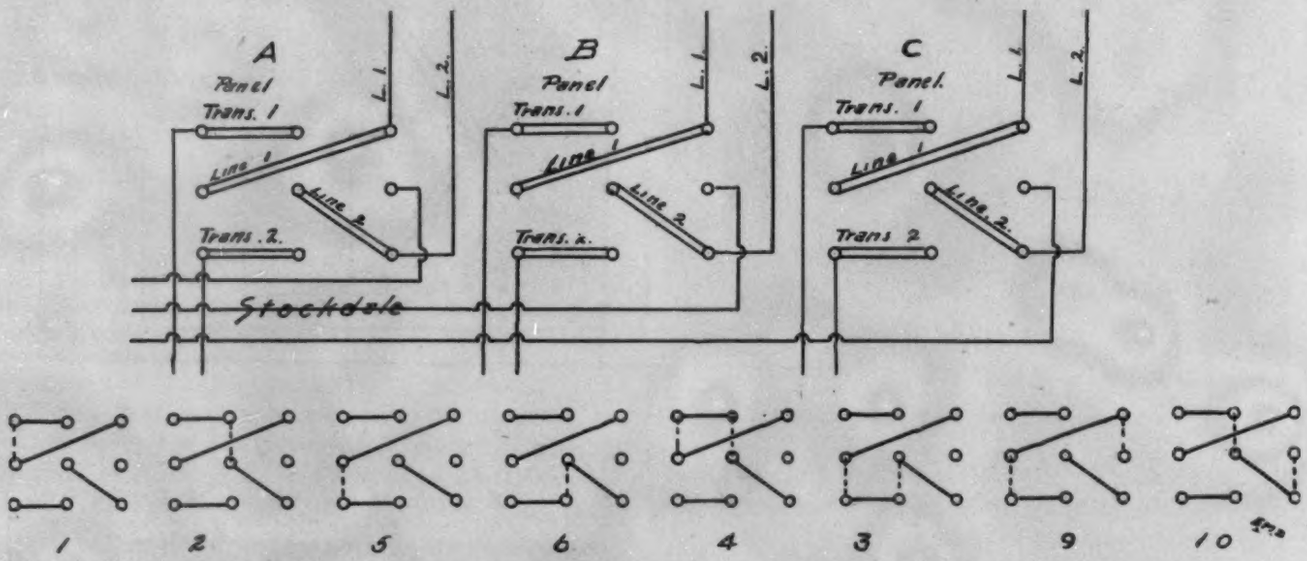
The design of the high tension switchboard as well as the innovation introduced in enclosing the high tension board in the sub-station, in the wooden cabinet as shown in illustration on page 92, is due to Dr. Cary T. Hutchinson, consulting electrical engineer of the Power Development Company.

From the high potential board the circuits proceed through the lightning arrester equipment before continuing on to line, and the problem of providing adequate protection against lightning is of such importance that special attention has been given to it. The Bakersfield transmission plant contains arresters that are believed to be an improvement over those used in other transmission systems. As is becoming well understood, high potential currents are generated in overhead lines by disturbances of the atmosphere and these currents may be similar to direct currents, or may have high frequency like alternating currents. It is necessary to protect each side of the circuit with arresters as a simultaneous discharge from each wire causes a short circuit from line to line through the ground connection of the arresters, and a slight discharge of atmospheric electricity may cause a heavy flow of current from the alternators; this would be sufficient to maintain an arc at the spark gaps in the arrester, destroying it.

An arrester should therefore permit the passing of high potential discharges, yet prevent the line current from following such a discharge and maintaining an arc, and this is found to have been very effectually accomplished by the installation of a lightning arrester combination consisting of a series of brass cylinders, a comparatively high resistance ground circuit and a choking ring inserted in the main line. This, in brief, constitutes the Wirt arrester, which is used at Bakersfield. Each leg of each three-phase circuit has two marble panels on each of which are fifteen brass cylinders measuring two inches each way and separated one thirty-second of an inch. These two panels are

coupled in multiple and grounded through four graphite rods, each three-fourths of an inch in diameter, twelve inches in length and having a resistance of approximately 100 ohms. The resistance interposed in the ground wire is, therefore, about 400 ohms. From the high potential board the circuit continues through two rings, each about twenty inches in diameter and coupled in series with the line. Each of these rings contains about 150 feet of No. 4 cotton covered magnet wire which are well taped and independently supported on high tension porcelain insulators. The lightning arrester connection then is cut in before the circuit proceeds to line.

The pole line also affords an innovation from the conventional practice in high potential line construction, particularly in the use of short poles over the long distance of level, unfrequented territory traversed. Such poles in the Bakersfield transmission measure 10 by 10 at the butt by 6 by 6 at the top and



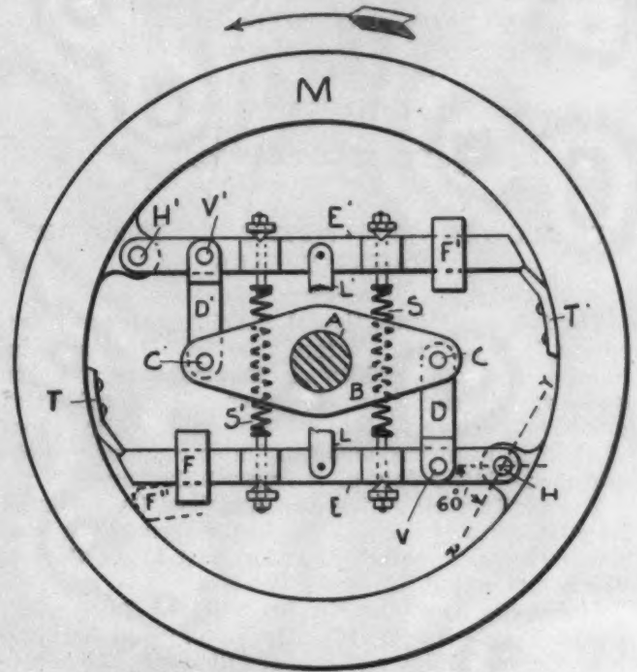
CONNECTIONS OF THE HIGH POTENTIAL BOARD—BAKERSFIELD SUB-STATION.

are only 26 feet long over all. They are placed 125 feet apart and carry two three-phase circuits of No. 4 B. & S. bare copper wire. The distance between wires on each side of the equilateral triangle of each circuit is twenty-four inches, the wires forming the apexes of the triangles, being on a short top cross arm, while the remaining four wires are on the lower and longer cross-arm. This construction is of far more pleasing appearance than that heretofore practiced where the reverse procedure was followed. The transmission is transposed at every mile, such transposition spans being but eighty feet in length, and the telephone circuit, consisting of No. 12, hard drawn bare copper wire, supported on glass insulators that are secured to the poles by wooden brackets at a distance of about three feet below the transmission lines, are transposed every third pole. Six-inch General Electric, triple petticoat, porcelain insulators are used throughout on the high tension lines and the total length of the main line is approximately 76,000 feet or about 14½ miles. As stated, the Stockdale line continues about ten miles beyond Bakersfield, and as it is an extension of the 10,000 volt circuit, the total length of transmission of the Power Development Company is practically 25 miles.

Stockdale and Bellevue constitute the districts where nearly the entire output of the plant will be consumed. At the former is located the magnificent residence of Mr. W. S. Tevis and the extensive farms of the Kern County Land Company, while at Bellevue the farms and land of the Company are continued and extensive cold storage and packing houses are being erected. This section is noteworthy as being almost the only one of magnitude in a valley in California which presents the continual verdure that is common to Eastern localities during the entire summer. In California the verdure ordinarily disappears in summer but in this portion of the Kern River Valley it is ever green owing to irrigation. The land company, however, owns hundreds of thousands of acres that are not irrigated, nor does the Kern river supply sufficient water for this at present uncultivated territory, and it is to the desire of the Kern County Land Company to irrigate this undeveloped domain that the Power Development Company really owes its existence. Although the soil is dry and parched at the surface an abundance of water exists twenty feet or so below and the most feasible means by which water may be pumped to the surface is afforded by the Power Development Company which has contracted to sell practically its entire output for pumping purposes to the Kern County Land Company. From a commercial standpoint therefore, the business of the Power Development Company probably presents the most favorable proposition upon which any electric transmission project is based. It has no bonded indebtedness;

it was built on a spot cash basis, and although it is at liberty to sell current to other parties, practically its entire output is contracted to a single consumer of the highest financial standing.

As stated heretofore the 10,000 volt line circuit merely passes through the high potential switchboard at the spb-station and is continued on to Stockdale



DETAILS OF THE GIRARD GOVERNOR.

and Bellevue, where a number of small sub-stations are being installed. These sub-stations are uniformly equipped with 15 k. w., special "type H" natural draft type transformers developed by the General Electric Company, in its long distance transmission work. In transformers of this type the primary coils, well taped and bound, are insulated from each other by thick layers of felt—in that shown the primary coils are eight in number. Between the coils of the primary and the secondary winding an air space of one-half an inch intervenes. The whole is mounted upon a solid iron foundation and securely braced, and is then covered with a corrugated iron cylinder provided with a ventilating roof.

From these transformers current is supplied for lighting and power purposes, the motors varying in size from two horse power to seventy-five horse-power, all being of the inductive type. The pumping stations consist merely of plain but substantial houses containing an induction motor driving a single centrifugal pump by a belt connection. The pump outlet emptying into an irrigating ditch of the usual form.

A retrospection of the plant of the Power Development Company impresses one with the careful study that has been given to effecting what may be termed practical refinments. At the power house, for instances, a studied effort has been to satisfy every reasonable desire of the employees. The cottage is a substantial, hard finished structure most conveniently arranged, furnished with unusually attractive fixtures and equipped with modern sanitry plumbing, while the sub-station is a perfect gem in the elegance and refinement of its polished oak and plate glass and tapestry furnishings.

The general direction of every detail of the installation of the transmission plant of the Power Development Company from its inception to completion has been in the complete charge of Mr. C. N. Beal, its Secretary and Treasurer. Dr. Cary T. Hutchinson of New York City designed and had charge of the electrical work and machinery, which was installed by the General Electric Company through its San Francisco office under the Chief Engineership of Mr. J. A. Lighthipe. The mechanical and hydraulic engineering has been handled by Messrs. Cobb & Hesselmeyer of San Francisco. W. R. Macmurdo of Bakersfield was the civil engineer in charge of construction and Walter James of the same place was consulting civil engineer. Chas. Webb Howard is President and W. F. Goad, vice-President of the Company, both being residents of San Francisco. Frank L. Whorf is Superintendent at Bakersfield, while J. F. Dearth and E. M. Beal are respectively the Superintendent and Chief Electrician of the power house.

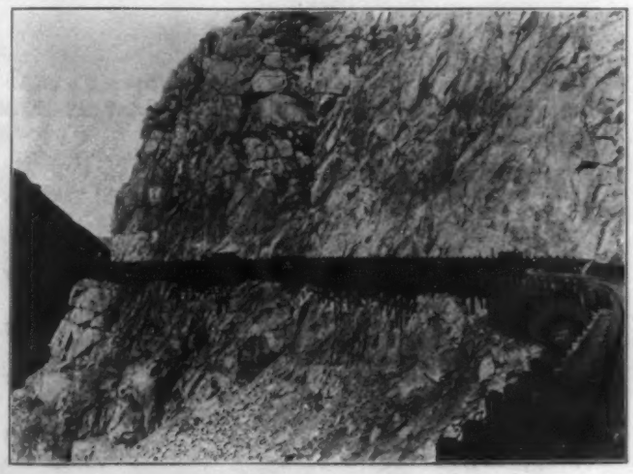
SOME DETAILS OF THE PLANT.

Following is presented detailed data concerning the plant of the Power Development Company:

THE FLUME.

Length	8,760 feet.
Width, inside ..	8 "
Depth, inside	6 "
Lumber used ..	967,360 "
Capacity ..	288 cubic feet per second.
Capacity	6,200 horse power.
Velocity of flow ..	6 feet per second.
Grade	5.28 inches per mile.

Weight of water per lineal foot, 3,000 pounds.



"OLD GIBRALTER."

PIPE LINE.

Diameter	66 inches.
Length of pipe line	541 feet.
Length of receiver	60 feet.
Maximum head to bottom of receiver	201.9 feet.
Effective head to nozzles	19.7 feet.
Pipe thickness	No. 12 B. W. G. to ⅜ inch.
Maximum gradient	287 feet, of nearly 54 per cent.
Maximum velocity of water	6 feet per second.
Capacity	2,500 horse power.

RECEIVER:

Length, 60 feet.

Internal diameter, 66 inches.

Materials, steel, 5-16 inches in thickness.

Circular seam laps, 3¼ inches.

Circular seam rivets, 64, ¾ inch.

Longitudinal seam laps, about 5 inches.

Longitudinal seam rivets, pitch, 3½ inches, double.

Distance between rows in longitudinal seams, 2 inches.

Bumped header of half inch steel with 10 inch by 16 inch man-hole in center.

Air chamber: 30 inch diameter by 16 foot length of Number 8 B. W. G. steel, connected to receiver by a 12 inch nozzle.

Charging tube: 6 inches in diameter by 16 feet in length of lap welded tubing and connected to receiver by 6 inch nozzle.

One 6 inch nozzle and blow off valve at bottom of receiver.

Lower end of pipe line carries a wrought iron flange to match

THE POWER HOUSE.

similar flange on end of receiver. These flanges are made of 4 x ⅝ welded wrought iron angle iron, faced for a gasket and drilled for 51, ⅛ inch bolts.

POWER-HOUSE EQUIPMENT.

Two sets 44 inch Girard water wheels at 257 r. p. m ,	1500 h. p.
Two General Electric 450 kw., 28-pole, 550 volt 60-cycle three-phase generators, having 471 amperes per phase	900 kw.
Two General Electric 17.5 kw., 4-pole, 125-volt exciters at 1100 r. p. m.	35 kw.
Seven General Electric 160 kw., air blast, 500 to 11,500 volt transformers (1 reserve)	160 kw.

THE POLE LINE.

Length of main line	76,000 feet.
Length of Stockdale extension	52,000 feet.
Size of poles, country division,	10"x6"x26' over all.
Size of poles, city division	12"x7"x40' over all.
Material of poles	Coast Redwood, sawed.
Distance between poles	125 feet.
Size of wire	No. 4, B. & S., bare.
Distance between wires	24 inches.
Transmission transposition	Every mile.
Telephone transposition	Every third pole.
Insulators	6 inch G. E. triple peticoat.

SUB-STATION EQUIPMENT.

7, General Electric 75-kw., air blast, 10,000 to 2080-volt transformers (1 reserve)	450 kw.
10, General Electric 15-kw., natural draft, 10,000 to 110-volt transformers	150 kw.

Transportation

THE POWER CONSUMPTION OF ELECTRIC RAILWAY CARS.

The following data, though deficient in many respects, is nevertheless interesting as showing the horse-power consumed by electric railways per car under various conditions of service. The Los Angeles and San Diego tests were made in 1893, while those of the San Francisco and San Mateo road were made during the latter part of the year following.

University Line of the Los Angeles Consolidated Electric Railway Co., Car No. 6; Brill truck, Westinghouse Gearless motor; Starting, 55.8 h. p.; Curves, 37.1 h. p.; Level at full speed, 19.9 h. p.

University Line, Car No. 101, Pacific Rolling Mill Double truck, Single reduction motor; Starting, 39.6 h. p.; Curves, 27.7 h. p.; Level at full speed, 17.8 h. p.

University Line, Car No. 9, Holmes rigged truck, single reduction motor; Starting, 39.2 h. p.; Curves, 28.2 h. p.; Level at full speed, 16.4 h. p.

West Lake Park Line, Car No. 4, Los Angeles, Brill truck, Single reduction motors; Starting, 44.3 h. p.; Curves, 27.5 h. p.; Grade, 53 h. p.; Level at full speed, 22 h. p.

West Lake Park Line, Car No. 3, Los Angeles, Brill truck, Westinghouse Gearless motors; Starting, 68.7 h. p.; Curves, 43.7 h. p.; Grade, 76.3 h. p.; Level at full speed, 23.5 h. p.

Vernon street Line, Los Angeles, McGuire trucks, Car No. 7, Sprague No. 6 Double reduction motors; Starting, 25.5 h. p.; Curves, 13.1 h. p.; Level at full speed, 5.7 h. p.

Maple Avenue Line, Los Angeles, Car No. 16, McGuire truck; Sprague No. 6 Double reduction motors; Starting, 22.3 h. p.; Curves, 9.7 h. p.; Level at full speed, 6.2 h. p.

San Diego, "Double Decker," two "W. P. 30" single reduction General Electric motors; Starting, 30 h. p.; Curves, 27 h. p.; Grade (5½ per cent), 35 h. p.; Level at full speed, 20 h. p.

San Diego double truck open cars, two "W. P. 30" motors; Starting, 27 h. p.; Curves, 23 h. p.; Grade, (5½ per cent) 30 h. p.; Level at full speed, 18 .h p.

San Diego single truck cars, one "W. P. 30" equipment; Starting, 20 h. p.; Curves, 17 h. p.; Level at full speed, 11 h. p.

Metropolitan Line, Baker street hill having a grade of 13.5 per cent consumed, 74 h. p., in a car equipped with two "W. P. 30" General Electric motors.

San Mateo Line; a loaded double truck car equipped with two "G. E. 800" motors, consumed 47.72 h. p., in

ascending the 9 per cent grade on Guerrero street between 26th street and Army street.

San Mateo Line; the double truck car as above consumed 67.5 h. p., in starting on the 7 per cent grade on Guerrero street, north from 22nd street.

San Mateo Line; in ascending the 7 per cent grade on Harrison street west from Steuart street, the following readings were recorded: 27 h. p., 55 h. p., 83 h. p., 86 h. p., and 62 h. p.

San Mateo Line; the Guerrero street hill of 11 per cent grade registered the following horse powers in ascending: 62, 69, 89, 85, 91, and 53 h. p.

San Mateo Line; Chenery street hill having a grade of 10.2 per cent showed a reading of 42.68 h. p., on the curve. To start on this hill showed power consumption varying from 80.43 h. p., to 85 h. p.

Gas

CHARACTERISTICS OF ACETYLENE.

Prof. V. B. Lewes gives the illuminating power of acetylene, as compared with other hydrocarbon gases, for the standard consumption of 5 cubic feet per hour, burned under one-inch water column pressure in the burner best suited for it, viz.:

Methane or marsh gas	5.2	candles.
Ethane	35.7	"
Propane	56.7	"
Ethylene	70.0	"
Butylene	123.0	"
Acetylene	240.0	"

The vitiation of the air in a room lighted by various methods to obtain the same quantity of light is manifestly less with the use of acetylene than by any other method. The extent of this vitiation is shown in the following table in which column 1 shows the cubic feet of gas consumed; column 2 shows the volume of carbonic acid produced from the consumption of gas as given, and in column 3 is given the number of adults in the room required to produce the same vitiation of air, viz.:

Coal gas flat flame No. 4	19	cu. ft.	10	cu. ft.	16.
Coal gas flat flame No. 5	22.6	cu. ft.	12	cu. ft.	20.
Coal gas flat flame No. 6	25.2	cu. ft.	13.2	cu. ft.	22.1
Coal gas argand	15.2	cu. ft.	7.9	cu. ft.	13.
Acetylene	1.2	cu. ft.	2.	cu. ft.	3.6
Kerosene oil lamp	....		....		22.3
Sperm candles (40 used)	....		....		27.3

The flame of acetylene, notwithstanding its high illuminating power when burned pure, is distinctively a cool flame, approximating 1,700 deg. F., while an 18-candle power coal gas flame will be 2,200 deg. F., and in some cases higher.

TRAVELED OVER 600,000 MILES.

A peculiar anniversary was celebrated in Berkeley a few days ago by Charles Sterns, a motorman on the Telegraph-avenue line. For twenty-four years he has made daily trips between Oakland and Berkeley as stage driver, car driver and motorman, and during that time his travels have aggregated 600,000 miles.

THE PENALTY FOR BREAKING A CONTRACT.

An interesting case in the Supreme Court of New York was recently disposed by the discontinuance of the suit of the Okonite Company against Holmes, Booth and Haydens.

The complaint showed that in June, 1895, Booth and Haydens sold to the Okonite Company 300,000 lbs. copper at 12¼ cents, and after delivering 50,509 lbs., stopped further delivery. The Okonite Company then in September, 1895, purchased elsewhere the balance of the copper at 14 cents, and then sued Holmes, Booth and Haydens for about $4,500, the difference. Holmes, Booth and Haydens denied the contract. An order discontinuing the suit was entered in the Clerk's office on April 21st, and on enquiry it is understood that Holmes, Booth and Haydens paid the Okonite Company about $2,800 for a settlement.

INDEXING SCIENTIFIC LITERATURE.

Scientific knowledge is advancing so rapidly, that a comprehensive catalogue of current scientific literature is greatly needed by every professional man who wishes to know what is going on. An international committee, appointed for the purpose, has now arranged for the publication of a catalogue of this sort, to begin with the year 1900. It is to be edited by a central bureau in London, and will include every original paper on pure science, whether published in a periodical, in the tansactions of a society, or in book form. Applied science, however, will be excluded, because the undertaking is sufficiently vast without it.

THERE ARE OTHERS, ELECTRICALLY SPEAKING.

A Colusa tramp, after being told that a substantial breakfast would reward the faithful devotion of his energies to the sawing up of a wood pile, took refuge in "moving on" to the next farm, but not until he had left on the saw buck a scrap of paper bearing lines attesting a delicate fidelity to the sacred precepts of his profession.

The lines ran:

"Just tell them that you saw me,
But you didn't see me saw."

THE EXIGENCIES OF RURAL JOURNALISM.

Printer's Devil (from Bungtown Banner office).—Say, de editor wants yer t'pay up yer next year's subscription in Bromo Seltzer, an' let him have it right away!

Druggist.—Why, what's the trouble?

Devil.—Well, a feller paid three years' back subscription in apple jack yesterday.—Puck.

ELECTRICAL TERMS SIMPLIFIED.

Telegraph—A fast friend.

Thunder-Clap—A weather report.

—Queensland Telegraph Gazette.

THE JOURNAL OF ELECTRICITY.

An Illustrated Review of the Industrial Applications of Electricity, Gas and Power.

OFFICIAL ORGAN OF THE PACIFIC COAST ELECTRIC TRANSMISSION ASSOCIATION.

SUBSCRIPTION PAYABLE IN ADVANCE. TERMS—DOMESTIC, ONE DOLLAR PER YEAR; FOREIGN, TWO DOLLARS PER YEAR. RATES FOR ADVERTISING ARE MODERATE.

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EDITORIAL.

AN IMPORTANT ANNOUNCEMENT.

The Pacific Coast Electric Transmission Association, at its Santa Cruz Convention, selected the "Journal of Electricity" as the Official organ and for the publication of all the papers, discussions and transactions of that most important body.

It was pointed out in a recent editorial that the Far West is the proving ground of electric transmissions and all will accede to the statement that the renown which the Pacific Coast has won in the electrical engineering world from its courageous pioneering of long distance transmissions, as is well merited as is the fame of the Golden State for the pluck and grit of those who pioneered it in the "days of '49." Portland pioneered electric transmissions for lighting on a large scale nearly ten years ago. Pomona pioneered 10,000 volt transmission in the winter of '92-3, then followed in rapid succession, Bodie and Walla Walla with single phase synchronous power transmission, Redlands with three-phase power transmission, Sacramento with its 3,000 horse-power transmission, Fresno with its longest distance transmission and Newcastle with its 15,000 volt transmission. Now the eyes of electrical engineers are upon Southern California, where a transmission of 3,000 horse-power eighty-two miles at 33,000 volts is under construction. Surely none will deny the Pacific Coast the honor of pioneering electrical transmission in America.

Thus has the Far West taken the lead and for this reason will other communities profit by its transmission experiences—experiences in which it is ripest. It is to be expected that most interesting problems should arise in the development of transmission enterprises; it is meet that their managers should seek interchange of opinion concerning these problems and that an association should be formed for mutual protection and the collection and dissemination of information relative to the generation, transmission and distribution of electrical energy. And, finally, it is natural that such association should choose as its mouthpiece the representative electrical periodical of the Pacific Coast, namely, "The Journal of Electricity."

Let the engineering world know then that in these columns alone may be found unabbreviated reprints of all papers and exhaustive reports of the proceedings of the Pacific Coast Electrical Transmission Association—the only body of its kind in existence—and wherein will be discussed with unreserved technical detail the experiences of the companies forming the association in all matters, whether in problems involving electrical, hydraulic or mechanical engineering.

THE JOURNAL BESTOWS A MEDAL.

The proverbial good fortune that popular report has ever attributed with directing the financial ventures of Mr. Charles R. Lloyd, seems to have deserted him in an interesting suit recently brought against him for above $14,000 on a promissory note given in payment for the water power at Kehl's mill in San Bernardino, Cal. It seems that when Mr. Lloyd established the San Bernardino Electric Light Company, he acquired this water power under representations that it amounted to about 190 horse power, but afterward he learned that the power available fell materially short of that amount, whereupon he refused payment on the note and suit was brought to recover.

There is nothing in any detail of this transaction to elicit wonderment, but the extraordinary feature is to follow: Relying on his past record of never having lost a suit, Mr. Lloyd was evidently indifferent to the necessity of taking technical precautions in his defence, as a result the case went to the jury with a charge from the court to the effect that the measurement of the horse power of a stream of water is a matter of individual opinion, rather than a matter of fact!

Now who shall be decorated with distinction in this justly conspicuous case? The ignorance of the court, which acted upon the testimony adduced, may

be overlooked, but the intellectual short-sightedness of Mr. Lloyd in this instance, accords him that honor and to him is awarded a leather trophy of great rarity which is attested to have cost something upward of fourteen thousand dollars net.

There are other brilliant individuals on this prolific occidental shore who are deserving of distinction for equally noteworthy achievements and to many of whom the Journal should award a similar leathern trophy. Mr. Lloyd is not the only nugget on the Klondyke.

WHERE ARE WE AT?

There are numerous questions in the category of business relations which inherently seem to be impossible of solution. To some the telephone industry appears to constitute a natural monopoly; others contend for the municipal ownership of quasi-public corporations and there are many who believe that gas and electricity, instead of being natural enemies which like cat and dog, fight between themselves at every turn and have common interest only in catching the fattened rat of public patronage, should advance in harmony along every line and together form the elements of one great lighting industry that shall stand ever ready to serve whatever variety of illumination the public may require. It is a pretty conceit, this idea of a single corporation that harbors no discord between the two great illuminating agencies that are so invariably at outs, but before committing one's self to its endorsement it is well for electrical industries to pause and put to itself the above query so apt in the vernacular.

Is there anything in the wedding of gas and electricity that is of disadvantage to the latter? Electricians generally will contend that there is, for the electric bride will in every case lose her name, then her identity and at last will be blended so effectually into the ways of her gaseous spouse that she will become the mere adjunct of a crochety consort who detests, yet endures her, because she is a favorite belle of the society in which he moves. He cannot get along without her for fear of being unconventional, so he takes her unto himself and makes the best of her, not for the good of her companionship, but purely as a matter of policy. The union is by no means a love match—rather is it a fruit of the crafty intrigue of long-headed business men who serve no master save their own financial betterment and who, like unfeeling parents of other countries, plan and carry out the wedding without consulting the interests of its principals.

Is the growth of the electrical industry advanced or retarded by its amalgamtion with gas interests? Is the universal knowledge that the sale of gas is relatively more profitable than the sale of electricity, conclusive evidence that if the gas intersets predominate the use of electricity will be discouraged whenever and wherever possible?

Does the motive which actuates gas interests to absorb electrical concerns lie solely in the idea of suppressing, in every way possible, a popular competing industry otherwise destined to be formidable? Has the long conservatism of the gas companies given them alone the wisdom to direct the affairs of electrical industry to the individual haven of its greatest good? Has it ever occurred that the consolidation of gas and electric companies resulted otherwise than in bettering the condition of the former as an industry and in worsting the condition of the latter as an industry?

In brief, can it be established as fact that the unification of gas and electricity does not invariably relegate the latter to the background and render it in every possible way impotent in all progressive and expansive development?

THAT BLUDGEONLESS BOGY.

Tradition, they say, hands down a fable of a visitor to a lunatic asylum who, after inspecting the various wards, entered the men's recreation grounds where several hundred inmates were amusing themselves in athletic exercises, or basking on the lawn, or otherwise finding enjoyment, each according to his inclination. The visitor was particularly impressed with a certain great stalwart lunatic whose muscles were as the gnarled oak, whose sharp eyes pierced javelin glances and whose presence was terrifying in its might. His physique was indeed a magnificent habitation for a demented brain, and the visitor in admiring the one, sorely pitted the other.

But the tiger-like keenness with which this lunatic watched every movement of the visitor was from the outset most disquieting to the latter. His every action is noted and aped; he walks and the lunatic walks; he quickens his pace and the lunatic does likewise; he stops and the lunatic stops too, always eyeing the visitor with the wild, fierce, yet cunning and hypnotic look so peculiar to madmen. The visitor is soon terrified at the thought that he may be in a lunatic's power, and determining to leave the grounds, he started toward the gate. The lunatic started too; he broke into a run, but the lunatic was at his heels; he dodged hither and thither, constantly increasing his speed, but the demented being shadowed his every movement until he fled with all the superhuman energy born of abject terror. Wildly on the chase continued until at times he fancied he could feel the hot breath of the mighty mad man upon him—more merciful, he thought, would the starving lions of the jungles of India be than this wild human monster. Oh, the acute mental tortures of the hapeles victim cannot be described! With failing strength he feels that the chase will soon be over, then, heaven only knows what horror will befall him. At last the end is come and, with the blood bounding through his veins, with nerves unstrung and with utter exhaustion and abject terror up-

on him, the poor hunted wretch can go no further. He reels in his terrified frenzy while the lunatic bounces to him and tapping him on the shoulder, cries out: "Tag, you're it!"

And so it will be with the Berliner bogy—that offspring of the Patent Office whose questioned legitimacy of birth has been settled, but whose intellectual soundness, so to speak, is so generally impugned. This bogy is of fearful mein, to the uninitiated. It advances, meances, receeds, then advances and menaces again, threatening the dismemberment of the hoped-for victim, and when at last it may perchance pounce upon the terror stricken, its threatened annihilation will be but a harmless stroke while its "Tag, you're it!" will tell that it is all but a game and one in which other fellow has his inning.

Passing Comment

An Editorial Review of Current Events and Comtemporary Publications.

A TRADE CATALOGUE BUREAU.

The mass of really valuable engineering information that annually appears in the form of trade catalogues is something inconceivably enormous, and for engineers to accumulate, systemize and preserve it is impossible. It is with pleasure therefore, that announcement is made of the recent organization of the American Catalogue Bureau of Cleveland, Ohio, which will, about October 1st, open free libraries and bureaus of business information in the fifteen largest cities of the United States where the general public may gain much valuable information concerning all lines of manufacturing. Such an enterprise if properly conducted, will form a veritable boon to all trades and professions.

It is with the view of assisting in the organization of this project that all readers of the "Journal of Electricity" are requested to mail one of their most recent catalogues to the American Catalogue Bureau at Cleveland, Ohio, without delay.

SAFETY IN LIGHTING MINES.

The fierce fire which recently raged in the Utica gold mine in Calaveras county proved a very expensive object lesson in demonstrating at least the financial wisdom of installing only the safest possible means of illumination in mines. The Utica mine, though a richly paying property, is yet lighted by the primitive method in which miners carry lamps on their hats, and the origin of the fire was due to the carelessness of a miner who, in trimming his lamp threw the lighted wick amidst a pile of timber. The mine is the largest quartz gold mine in the world worked by the chlorination process, having 200 stamps and fourteen roasting ovens and employing between 600 and 700 men, with a monthly expenditure of $70,000. It is estimated that the annual output equals $1,800,000.

The art of incandescent electric illumination has long since reached such perfection that in properly installed plants the occurrence of fire from its circuits is a virtual impossibility, and money spent by mine owners for properly installed incandescent lighting systems is an expenditure made in the nature of the proverbial "stitch in time."

THE WORLD'S GREATEST ELECTRIC PLANT.

The last number of the Journal announced the awarding of a contract to the Westinghouse Electric and Manufacturing Company for the building and installing of fifteen, 5,000 horse-power polyphase generators in the works of the St. Lawrence Power Company, to be located at Massena, N. Y., and a brief description of this, the world's greatest electrical generating plant, is of interest:

The company is to take water from the unnavigable channel of the St. Lawrence at Long Sault Island, and to carry it thence through a canal about three miles in length to Massena, which is located on Grass River. This is a small stream flowing parallel to the St. Lawrence and re-entering that river below its rapids, while at the rapids, the level of Grass River is 45 feet below that of the St. Lawrence. At Massena, the water from the proposed canal will have a head of about 47 feet and the canal is to have a capacity of 150,000 horse-power. The water, therefore, is to be taken from the St. Lawrence above the rapids and after actuating the wheels, will return to the St. Lawrence through the Green River acting as a tail race.

The generators and turbines are of the same size as those used at Niagara but differ therefrom in that they are of the horizontal shaft type, forming direct connected sets running at 180 revolutions per minute. Each of the generators will weigh 350,000 pounds, the weight of one piece in each being about 125,000 pounds. Each machine stands about 22 feet high above the foundation and occupies a floor space of 22 feet by 18 feet. The shaft carries a revolving field, consisting of 20 external projecting pole pieces and having an external diameter of 15 feet by about 3 feet in width. The field ring revolves at a speed of nearly two miles a minute and the centrifugal force is such that each pound at the circumference tends to fly outward with a force of nearly 100 pounds. Three-phase current is to be produced at a frequency of 30 cycles per second.

TECHNICAL TERMS DEFINED.

Water Rheostat:—A wooden box that cannot be made to hold water. Commonly termed, when tight, "just an ordinary tank."—J. F. Dearth.

Fraternal

THE TRANSMISSION CONVENTION AT SANTA CRUZ.

As heretofore published in these columns the Pacific Coast Electric Transmission Association was organized in San Francisco on June 7th last, having for its object as stated in its Constitution, "the mutual protection, collection and dissemination of information relative to the generation, transmission and distribution of electrical energy. The electric transmission companies constituting its membership at present are the Blue Lakes Electric Power Company, of San Francisco, The Big Creek Power Company of Santa Cruz, The Central California Power Company of Sacramento, The Nevada County Electric Power Company of Nevada City, The Portland General Electric Company of Portland, The Power Development Company of Bakersfield, The San Gabriel Electric Company of Los Angeles, The Sacramento, Electric, Railway and Gas Company of Sacramento, The San Joaquin Electric Company of Fresno, and the Southern California Power Company of Redlands.

The first business meeting of the Association was held in Santa Cruz, Cal., on August 17th and 18th, there being present Messrs. C. P. Gilbert of Sacramento, Robert McF. Doble of San Francisco, F. W. Swanton of Santa Cruz, A. C. Balch of Los Angeles, C. N. Beal of Bakersfield, E. W. Sutcliffe of Sacramento and J. S. Eastwood of Fresno. Those present by invitation, were Messrs. J. A. Lighthipe, R. S. Masson, F. M. Pickering and A. M. Hunt of San Francisco, W. G. Barrett of Los Angeles, C. W. Quilty and H. J. Edwards of San Jose, C. E. Lilly H. Willey of Santa Cruz, F. J. Cramm of Chicago.

The subject for the special consideration of the meeting was the general one of high potential insulators, concerning which papers were read under the following themes:

"Insulators," by Dr. C. Van Norden, outlining experiences on the 15,000 volt transmission lines of the Central California Electric Company.

"Insulators for use in the Transmission of Electric Power," by T. A. W. Shock, being an account of interesting experiences with insulators on the Folsom-Sacramento transmission line.

"Line Construction," by J. S. Eastwood of the Fresno transmission, being an exhaustive discussion of the essential features of pole lines.

"Insulators for Use On Transmission of Power Lines Operated at High Voltage," by Henry D Sears, describing desirable qualifications and the process of manufacture of high tension insulators.

These papers which will be reproduced in full in the next number of "The Journal of Electricity," the exclusive organ of the Transmission Association, evoked discussion of the greatest interest and value to electrical engineers.

Early on the morning of the eighteenth, the entire party started in carriages for the eighteen-mile drive to Big Creek in the Santa Cruz mountains, where the generating plant of the Big Creek Power Company is located. Arriving there the reservoir, flume, pipe line and station of the company were inspected, and considerable interest was evidenced in the work and plans of the Company. Among the other interesting features examined was the new dam which is now being completed by the Company, which has a crest of 540 feet, is 32 feet high and will impound water on what is known as the West Branch of the Big Creek about 1300 feet above the sea level. This dam will hold water covering 20 acres and will deliver 500 horsepower for four months each year. Two other reservoirs of the same capacity are contemplated and after they have been built the Company will build transmission lines to San Jose.

After returning from the tour of inspection and partaking of a sumptuous collation at the power house, the members resolved themselves into executive session, during which the "Journal of Electricity" was accorded the official organship of the Association with the exclusive right to the publication of all papers and discussions before it.

The next meeting of the Association is to be held in Sacramento on October 20th, and to continue thereafter as long as necessary. The subjects to be considered at this meeting will be a continuation of the insulator question with an especial consideration of the problems attending protection against lightning. It is probable also that hydraulic matters will receive considerable discusson. During the Sacramento Convention, the Folsom power house of the Sacramento Electric, Railway and Gas Company will be inspected and a trip will be made over the 15,000 volt transmission system of the Central California Electric Company at Newcastle.

Electro-Economics

THE ACCURACIES OF THOMSON RECORDING WATTMETERS.—I.

By H. N. Sessions.

Owing to the rapid development and extensive use that has taken place within the past few years in the styles of electric meters, a discussion on the points yet to be improved will perhaps be of interest. Of course it cannot be denied that the old zinc-copper-chemical meter is the most accurate of all; but the great expense connected with taking statements from and maintaining this meter has forced lighting and power plants to abandon its use and to adopt the mechanical meter in its place. San Francisco may well be proud to be known as the first city to determine this difference and to use the mechanical meter exclusively on all customers using low potential current.

Among mechanical meters the Thomson recording watt meter has been generally adopted to ascertain the watt-hour consumption and output of various electrical apparatus. There are certain features connected with the construction and operation of this meter however, that may readily be discussed advantageously. The mechanical meter has so far satisfied both those selling and buying electricity for the reason that those who sell are confident of their meters, and on the other hand, those who buy electricity cheerfully accept as

accurate the measure of work of a science not understood by them and upon being charged with a drop or raise in the bills of 10 or 20 per cent, their only alternative is to credit the variation to an unconscious use of light or power. Nevertheless, years of practice have shown that this 10 per cent or 20 per cent variation may be wholly in the meter itself.

Before we investigate the causes that may make meters fast or slow after they are installed, let us first study and understand their general construction; then we will readily see that it is next to an impossibility for a meter to register with absolute accuracy and contend with the conditions to be met with on the outside.

The meter may be described as being a shunt motor, having very low resistance fields which are connected in series with the lights or power to be used. The armature circuit of very high resistance is connected straight across the service mains and provided the potential does not change, the armture strength remains constant. The speed of the meter depends upon the strength of the fields which in turn is in proportion to the number of lights or amount of power in series with them, or in other words, on the amperage traversing the field coils. The armature shaft revolves in a vertical position, its weight resting on a lower jewel. A worm on the shaft is meshed to a gear in connection with the series of gears which moves the indicating hands. The speed of the meter is reduced by an inductive brake consisting of a copper disk carried by the armature shaft and revolving between the poles of permanent magnets. These magnets may be shifted to or from the center of the disk, thus decreasing or increasing the leverage of drag and regulating the speed.

The power absorbed by the disk by induction adjusts itself to any load that the meter may be running on, because the amount of current induced in the disk is in exact proportion to its speed. The friction on the jewels, gearing and commutator of the meter is of sufficient amount to absorb a large percentage of the power necessary to propel the meter on low loads. Inasmuch as this percentage of power increases as the load decreases, the meter is often very slow on light loads and sometimes stops on the smallest loads. Steps have been taken to balance this friction by inserting within the field of a starting coil of very fine wire connected in series with the armature circuit; but, with the friction of the meter thus balanced, it very often registers when no current is being used, especially when vibration is met with.

After the meter has been carefully calibrated and balanced on light loads, it will generally be found fast on heavy loads, where the friction that gave so much trouble on light loads now enters as a very small factor. There will be a point, however, between minimum and maximum loads, where the meter will record correctly.

One point about the watt-meter, and perhaps not the least in the favor of the companies selling light and power, is the very small percentage fast that their meter would have to record on large loads to discount a large percentage slow and even a stoppage of the meter, on small loads. For example, a meter reading 5 per cent fast on 600 lamps burning for 1 hour would discount an error of 50 per cent slow on 10 lamps burning 6 hours.

After discussing the construction of the meter, we may now look into the changes that may occur from surrounding influences after it is installed. Any magnetic bodies such as motors, magnets or heavily loaded feeders, when placed at the sides of the meter, will influence it by helping to diminish or increase the strength of the fields within, making it run fast or slow, or even backwards, when no current is being used. The permanent steel magnets which retard the motion of the disk often lose their strength through aging, thus making the meter run fast and on the other hand as the meter is not dust proof, iron particles might collect on the magnets and slow it down.

A very important feature which causes a great deal of trouble is the high resistance coil of fine wire in series with the armature. In damp places, owing to the difference of potential between the turns and layers of this resistance, sections of it often become short circuited, causing an increase of current in the armature and again the meter is made to run fast. But if too great a section of the resistance should be cut out the amperage would rise beyond the carrying capacity of the wire and result in burning out the resistance. This of course would open the shunt circuit and cause the meter to stop.

It is impossible to balance the friction of meters where there is vibration, the reason being that the balancing force remains the same and with vibration the amount of friction is continually changing. Suppose the meter to be standing still and balanced on no load. A vibration wil tend to remove the weight of the armature shaft and disc from the lower jewel, thus lighting and overbalancing the friction and causing the meter to register without using current. The working parts of the meter give very little trouble if cleaned regularly.

In view of this discussion regarding the facts concerning electric meters, not only the makers and sellers of electricity should inspect their meters, but, in many cases, it would profit the consumers to have their meters independently experted.

THE PACIFIC COAST GAS ASSOCIATION.

The annual meeting of the Pacific Coast Gas Association was held in San Francisco in the middle of July, as usual, and during which the following papers were read and discussed:

"Spontaneous Ignition of Coal," by John L. Howard, San Francisco.

"Reminiscences," by Mr. F. H. Eichbaum, San Francisco.

"Value of Small Gas Bills," by Mr. W. W. Gillespie, San Francisco.

"From Coal Gas to Natural Gas," by Mr. John Kempf, Jr., Salt Lake City, Utah.

"Small Lighting Plants and Their Management," by Mr. Thos. D. Petch, Eureka, Cal.

"Practical Suggestions," by C. E. Burrows, Walla Walla, Wash.

"Uniformity of Accounts," by Mr. C. O. G. Miller, San Francisco.

"Municipal Control," by Mr. C. W. Quilty, San Jose, Cal.

"A Short History of a Long Life," by Mr. C. M. Converse, San Francisco.

"Recuperative Benches for Coke and Coal Firing," by Mr. D. R. Russell, St. Louis, Mo.

"Card Bookkeeping," by Mr. V. Stow, San Francisco.

"Gas as Fuel," by Mr. F. Foveaux, San Francisco.

"Wrinkle Department," edited by Mr. M. C. Osborn, San Diego, Cal.

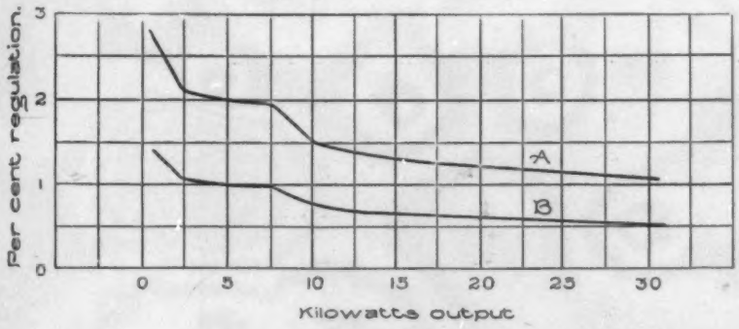
"Experience Department," edited by Mr. John Clement, Red Bluff, Cal.

Illumination

THE USE AND ABUSE OF TRANSFORMERS.—II.

(Continued from page 83)

REGULATION, a very important property in a good transformer is regulation—that is, its ability to hold its secondary voltage at or near a particular value, irrespective of load. On the regulation depends in a large measure the character of the service that may be rendered, for it determines the variation of voltage to which the lamps are subjected, and inasmuch as the light given by a lamp, and its commercial life, vary very rapidly with the voltage, the importance of fine regulation in improving the illuminating service, and in insuring durability of lamps is self evident. It has generally been considered difficult to secure



at the same time low core loss and the very best regulation, the relation between the two in transformer design being such that in improving the one the other may be impaired. In the Type H transformers, the magnetic leakage and the losses in the copper are both small, and these are the two factors which chiefly influence regulation. The regulation of these transformers is correspondingly good. That the copper losses must be small is attested by the high efficiency. The failure in regulation due to magnetic leakage, is greatly reduced by the use of a single magnetic circuit of such shape that the possible paths for the leakage of magnetism are unfavorable and long. Hence not only is the regulation good in ordinary service, but it continues to be good when the load possesses considerable inductance, as in the case of operating motors. The net result of the care that has been taken in the design and construction of the Type H transformers is not only to raise the efficiency to a point heretofore untouched in commercial transformers of corresponding sizes, but also to secure this efficiency, and the remarkable low core loss already referred to, with regulation correspondingly excellent. The table following emphasizes this point in a very striking manner.

This table is drawn from a series of very careful tests on commercial transformers made under the direction of Prof. D. C. Jackson, of Madison, Wis., and recently published. The tests were made on transformers of about the same size (averaging 1.500 watts capacity), from nine different makers. One of the former types of General Electric transformer is shown in the list. The others are by other makers. The following is the table, to which is added the regular figure for the Type H transformer.

NUMBER.	REGULATION PER CENT.
1	3
2	2.5
3	3.5
4	4
5	2.5
6	3
7	5
8	5
9	2.5
H	2.62

The figure for the Type H transformer is taken from the standard 1,500 watt size. It is worth noting that in the table indicated, Numbers 7, 8 and 9 were of greater capacity than 1,500 watts, the last mentioned being a 2,500 watt transformer.

Further reference will be made to this admirable series of transformer tests, but the data just given shows that in obtaining the all important properties of low core loss and great general efficiency, there has been sacrificed in the Type H transformer nothing of those excellent regulating properties which are essential to fine commercial service.

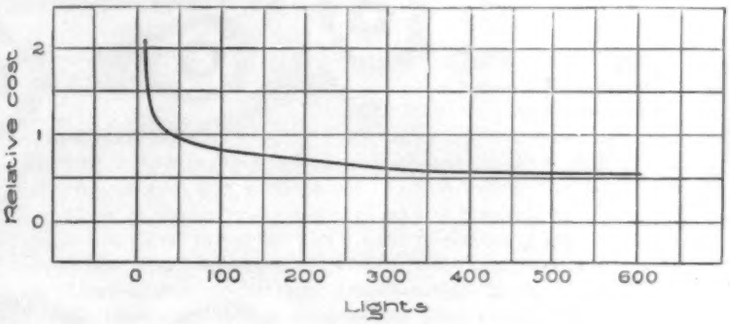
In the accompanying curve, A shows the regulation of "H" transformers in per cent of the voltage. The drop taken is from no load up to full load. Bearing in mind the fact that these transformers should be so installed as to give normal voltage under the ordinary conditions of load and not at full load, it will be seen that any one of these transformers, even the smallest size, is capable of holding the pressure on the lamps steady within 1.5 per cent under all variations of load and under all working conditions much closer than this. Curve B shows the maximum variations of voltage which will be obtained with proper care in installation for these various sizes of transformers. That the regulation may be so close, without any compensating sacrifice, speaks volumes for the care with which these transformers were designed and the skill with which the construction has been carried out.

Part ii

PROPER AND IMPROPER METHODS OF DISTRIBUTION.

The alternating current transformer should be regarded, so far as distribution is concerned, as a generator which indeed has an enormously high efficiency and requires no attention, but which is subject to the same general laws as regards distribution as any other source of electricity. A transformer plant is on a small scale a power transmission plant, the generating station being the primary source of energy and the transformers the secondary source of energy.

In the early days of transformer work it was the custom to install one of these secondary generators for each customer to be served, so that the transmission plant would be regarded as made up of a main generating station,



with secondary generators equal in number to the number of patrons. The distributing system connected to each secondary generator was then very short, simply consisting of house wiring. The result was that the transformers were on the average of very small size, corresponding to perhaps twenty-five lights capacity.

Now it is a well known fact that in any class of electrical machinery the cost per kilowatt decreases as the output increases, so that for example, a 100 kilowatt generator costs less that two 50 kilowatt generators, and these in turn less than four 25 kilowatt generators. The same holds true of transformers. One 10,000 watt transformer costs less than two 5,000 watt or four 2,500 watt transformers. Consequently it is for the interest of any one installing transformers, to use, in so far as it is possible, trans-

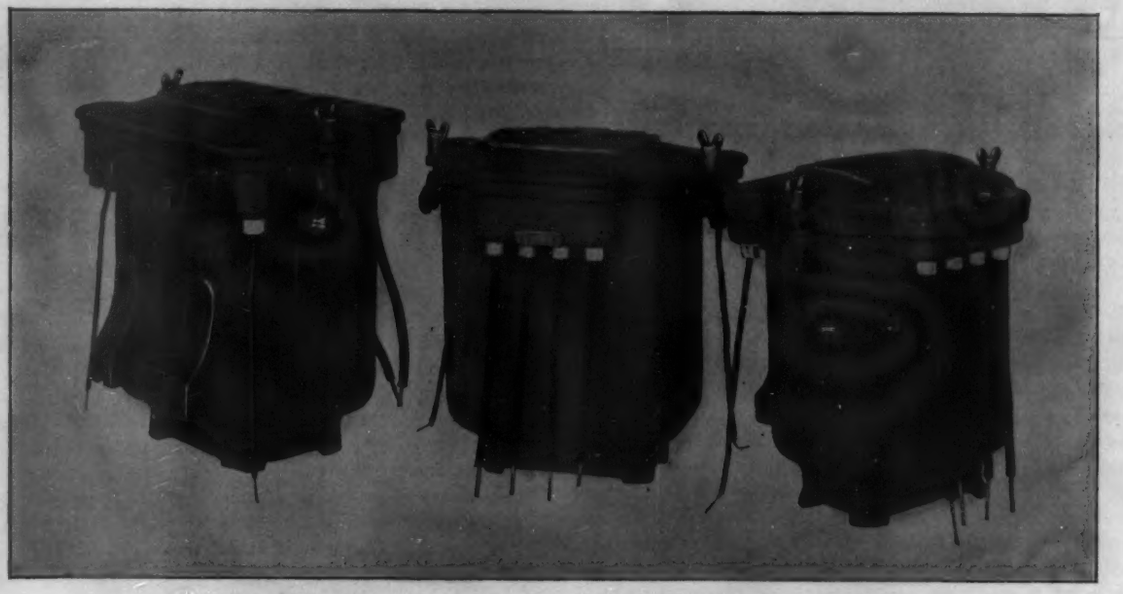
formers of such size that their cost shall be reduced as far as practicable. Of course if one transformer is made to serve several customers, the average distance over which lights have to be distributed is greater than if one transformer were installed for each customer; that is, in the secondary distribution more copper per light has to be installed than if the secondaries were shorter. Consequently if one decreases the cost of the transformers, by using larger sizes and fewer of them, the cost of the distributing system for the same service is somewhat increased.

Evidently then, a point will be reached where it will not pay to further increase the size of the transformers used, owing to increase in the cost of the copper. At the same time on this consideration alone it pays frequently to use transformers large enough to serve several customers, especially if these customers are conveniently situated. If, for example, a 100 light transformer costs $90 and five 20 light transformers cost $140, it would evidently pay to put in $50 worth of copper in the secondaries for the sake of using the larger transformer—the loss in the secondaries being retained at the same amount. This extra $50 is better spent for copper than for transformers, because the depreciation is less.

The preceeding curve shows the variation in cost of transformers per light, with increase in size, based on the market price of several well known makers. By applying this data to any concrete case it is easy to figure the amount of copper it would pay to put into the secondaries to avoid the use of small transformers; but this gain, which is purely a commercial one, and quite obvious, is small compared to the gain which may be made in other ways by the same process of increasing the average size of transformers used to supply any given district. For instance, in employing Type H transformers, the efficiency of a 100 light transformer at full load is 97 per cent; the efficiency of approximately a 20 light transformer is about 95.5 per cent, giving an advantage of 1.5 per cent in efficiency for the large transformer as against the smaller one. At one-quarter load the difference is still greater, the efficiency being 95.1 per cent for the 100 light transformer and not over 92 per cent for the smaller one. So in addition to the gain in first cost, there is a positive gain in efficiency, which means that each lamp supplied to a customer through large transformers, costs something like 2 per cent less than if they were supplied through small transformers. This means a small but certain source of profit, and what is thus true of the Type H transformer is true with immensely greater force of most of the other transformers in use, of which the efficiencies are generally lower than that of the Type H transformers at full load, and proportionately still lower at partial loads and in smaller sizes.

This is a second good reason for employing a moderate number of secondary generators instead of a large number, but this is not all. Suppose one undertakes to supply 100 houses with lights. Each of them, we will say, is wired for 40 lights, making a total of 4,000 installed. If each house has its own individual transformer, that transformer must be large enough to supply all the lights in the house, for there will be times when all the lights will probably be in service. To economize transformer capacity as far as possible, it is the custom under these circumstances to employ a transformer, which at normal load will carry a somewhat smaller number of lights than those installed, trusting in the event of an emergency that it will carry successfully somewhat over its rated capacity, as most transformers will.

(TO BE CONTINUED.)



TYPE H TRANSFORMERS.—1500—1000—600 WATTS.

INCORPORATION

San Francisco.—The Central Light and Power Co. Capital stock $1,000,000, in 100,000 shares, $50,000 of which has been subscribed. Directors: Frank Pauson, who subscribed $15,000; C. L. Ackerman, $15,000; Joseph Naphtaly, $10,000; A. E. Brook-Ridley, $2500; Joseph M. Loewe, $3000; Samson Gerst, $2500; J. W. Pauson, $2500.

This company has bought the Emporium plant, situated in the Parrott Building, in addition to lighting, which it will furnish, extend its outside lighting business by laying underground mains throughout the principal business section of the city. Mr. Brooke-Ridley is electrical engineer for the company and Mr. Napthaly is superintendent.

AN ELECTRIC TRICK FREE.

The Pacific Electric Company, of La Crosse, Wis., has secured the selling control of a clever device called the "Electrical Trick," by means of which a piece of money can be made to disappear in a mysterious manner so that even a very clever person would fail to detect how the illusion was accomplished.

The company uses this to advertise its Shade Lamps and Dental and Surgical Lamps and will be pleased to send it to anyone who will write for same, inclosing 4 cents in stamps to cover cost of mailing.

Personal

Mr. F. J. Cram of the Electrical Appliance Company of Chicago is on the coast in the interests of his house.

Mr. Sidney Sprout has been selected for the supervising electrical engineership of the Rawhide Electric Power Company.

Mr. B. C. Van Emon has been promoted to the managership of the Electrical Engineering Company of San Francisco, vice Mr. C. B. Sessions, resigned.

Mr. J. H. Thatcher, of Portland, Ore., secretary and superintendent of the Oregon Telephone and Telegraph Company, was a recent visitor to San Francisco.

Mr. J. M. Halliday, late superintendent of the Folsom power house of the Sacramento Electric, Gas and Railway Company, is now on the road for Yates & Co., oil dealers.

Mr. Jno. E. McGillivray, late of the equipment department of the Pacific Telephone and Telegraph Company, has become associated with the Brooks-Follis Electric Corporation in the capacity of telephone expert.

Mr. H. M. Kebby, prominent in California in the early days of cable railway building, but who has for several years past been located in various Eastern cities, has returned to San Francisco and has established an office at 59 First street as consulting engineer for street railway, power and electric plants.

Mr. M. A. DeLew, a well known electrician of Sacramento, and Miss Alice May Jordan, the accomplished daughter of Mr. and Mrs. L. C. Jordan, were the recipients of the heartiest congratulations of their many friends on the occasion of their marriage on August fourth, and to these congratulations the Journal of Electricity extends its kindest benediction.

Mr. E. J. Hathorne, auditor of the Fort Wayne Electric Corporation, is in San Francisco on business connected with the San Francisco agency. Mr. Hathorne was receiver of the old Fort Wayne Electric Company and is now secretary of the Fort Wayne Lamp Company, and it is probable that a result of his visit will be evidenced in the infusing of new energy into the San Francisco office of the Fort Wayne Electric Corporation. Mr. Hathorne resides in Boston and Mrs. Hathorne has accompanied him on his present trip. They are stopping at the Palace Hotel.

Educational

HEALD'S BUSINESS COLLEGE GRADUATES.

Following is a list of graduates of Department of Electrical Engineering of Heald's Business College, San Francisco, for the term just closed: H. A. Cave, Eureka, Cal.; F. W. Gale, City; H. D. Thaxter, Carson, Nev.; B. T. Viall, City; R. M. Nevins, Selma, Cal.; Geo. Heath, City; W. E. Tuft, Alameda, Cal.; W. O. Jennings, Red Bluff, Cal.; A. W. Stetson, City; Geo. Wagner, San Leandro, Cal.; J. Calvert, Mound House, Nev.; H. Schwartz, Alameda, Cal.; M. Konigsberg, City; A. Raabe, City; L. C. Cutts, Santa Rosa, Cal.; W. A. Genesy, Carson, Nev.; C. C. Hansen, San Rafael, Cal.; H. G. Black, San Leandro, Cal.; A. L. Sobey, Sausalito, Cal; H. Dorgeloh, City; J. Christenson, Salinas, Cal.; Dr. H. B. Pinney, Oakland, Cal.; J. Fortune, City; Carl Symonds, Mare Island, Cal.; Frank Pedlar, Oakland, Cal.; Geo. R. Knox, San Leandro, Cal.

The motion for injunction in the suit of Cahall vs, Babcock & Wilcox for infringements of patents has been decided in favor of The Babcock & Wilcox Company in the U. S. Court, Western District of Pennsylvania.

Industrial

In Responding to Advertisements in this Publication, please mention "The Journal of Electricity."

FREE TO STEAM USERS AND ENGINEERS.

Engineers of whatever profession, the world over, recognize the hand book "Steam" as issued by the Babcock & Wilcox Company to be at once the finest, most accurate and comprehensive volume that has ever appeared concerning the generation and use of steam and the manufacture and development of steam boilers. A new edition of this celebrated work has just been issued and will be mailed free to any address on application to the Babcock & Wilcox Company, 32 First street, San Francisco.

Those who are interested in steam plants, will find a great deal to instruct them in the elaborate display which Charles C. Moore & Co. have made in the machinery section of the Mechanics Institute Fair, now being held in San Francisco. There can be seen a working model and sample parts of the latest type of the Babcock & Wilcox boilers, together with many examples of the high grade machinery that they have widely and satisfactorily installed in

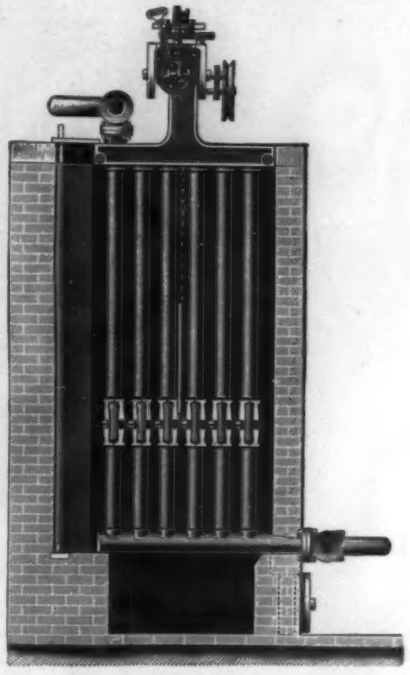


FIG. 1. CROSS SECTION THROUGH ECONOMIZER CHAMBER.

every part of the Pacific Coast and Hawaiian Islands. A visit to this exhibit can not but be most interesting and instructive, for there will be seen Babcock & Wilcox boilers, Green's fuel economizer, New York Safety, Hamilton-Corliss and McIntosh & Seymour engines, Stratton separators, Goubert heaters, Snow steam pumps, Quimby pumps, Hyatt roller bearings, Bundy traps, Edmiston filters, Wheeler condensears and Hopper purifiers.

That the reader will find something to his advantage in visiting this exhibit, is unquestioned, for novel devices of the greatest utility are there shown and their workings fully explained. Among these innovations special reference may be made to Green's fuel economizer for steam boilers. Users of steam power are fully aware that in all cases, whatever the construction of boiler, a large proportion of heat generated escapes by way of the chimney and that the highest possible degree of economy can not be attained so long as heat, which is expensively generated, is thus al-

lowed to go to waste. Green's economizer is recommended as being specially adapted for utilizing this waste of surplus heat from steam boilers,and by placing it in the main flue leading from the boilers to the chimney stack, it effects, in many cases, a saving of over 15 per cent of fuel by heating the feed water to a temperature very much above the atmospheric boiling point before entering the boilers. This apparatus is already applied to over 150,000 boilers which alone attests its value, but in order that an accurate idea of the saving it effects may be conveyed, the citing of an only two specific instances, may not be amiss. A report of a series of tests lasting seven days and made by the chief engineer of the South Chicago Railroad Company, which burns oil, shows that Green's economizer effected a saving of 15.76 per cent of fuel, which amounted to 251 gallons daily. At Cheney Bros.' silk works at South Manchester, Conn., feed water enters the boiler at a temperature as high as 295 degrees, the value of which will not be under estimated by an one conversant with steam engine practices.

Among the recent orders which Charles C. Moore & Co. have secured appears the contract for the heating plant for the Roman Catholic Theological Seminary at Menlo Park, consisting of two Babcock & Wilcox boilers and special heating apparatus built by the Goubert Manufacturing Company. They have also added the Belmont school to the list of educational institutions using Babcock & Wilcox boilers; these boilers being in use at both Stanford University and the University of California. Additional sales of Babccok & Wilcox boilers have also been made recently to different wine growers in Sonoma Valley and to the California Wine Growres' Association.

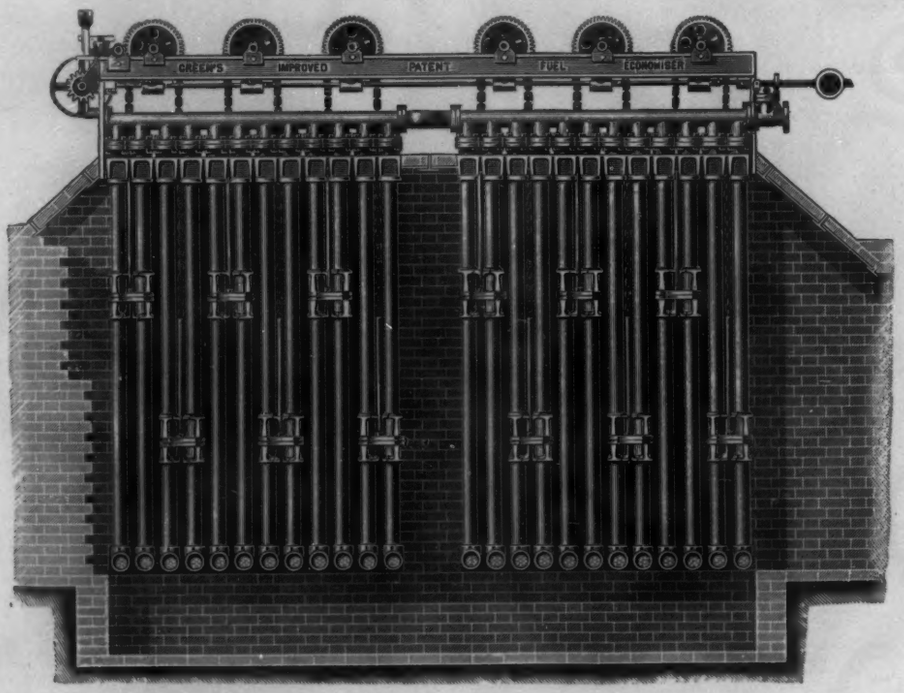


FIG. 2. LONGITUDINAL SECTION THROUGH ECONOMIZER CHAMBER.

GROWING AND PROSPERING.

The Brooks-Follis Electric Company has been incorporated as the Brooks-Follis Electric Corporation, and on September 1 the new corporation will enlarge its premises by also occupying the store next door at 525 Mission street, where C. B. Kaufman & Company are at present located.

The large quarters will give the Brooks-Follis Electric Company much needed room, as the present store is badly cramped with the heavy stock carried. No further evidence is required to demonsrate the great popularity of this concern than a simple reference to its modest origin two years or so ago, its phenominal growth in a field which was, it was said, already overcrowded, and its present position as one of the leading electric supply houses of the Pacific Coast. Its unprecedented success may be attributed to prompt shipments, moderate prices, personal popularity and liberal use of printers' ink.

ELECTRIC POWER DISTRIBUTION.

It has ceased to be a question as to whether electric lights shall be installed in office buildings, apartment houses, hotels, etc., and whether power shall be distributed electrically about new mills, factories and work shops. To-day the questions of first importance are what apparatus shall be used and what system of distribution employed.

In selecting a dynamo for electric lighting the matter of toughness and durability should be given much greater consideration than the matter of the very lowest first cost. Especially where two or more dynamos are to be employed, the matter of strength and abaility to carry temporary overloads cannot be measured against a trifle of first cost, which is also true of a dynamo having a comparatively high efficiency under partial loads.

With the approach of darkness the load on an electric light plant increases with more or less rapidity, depending on the character of load. Where two or more dynamos are employed, each dynamo should be able to carry for a reasonable period an overload of 25 per cent, which condition should be reached on the first dynamo before the second is thrown in. This is especially true of direct-connected dynamo and engine sets, and is conducive to the best efficiency of the steam plants.

The system of distribution of electricity for lighting are so generally understood and so thoroughly developed that construction firms of recognized reputation can be relied upon to install plants and wire buildings after well-designed plans and in a thoroughly satisfactory manner. Too much importance, however, cannot be

given the substantial and thoroughly first-class character of the entire installation.

In considering the type of dynamo, the system of distribution, and the applications of types, capacities, speeds and methods of control of motors to be employed in the distribution of power from a central station plant about a city or town, or from a central plant in a mill or factory to the several buildings or departments and thereafter to the different machines, tools, or processes, becomes a much more complex subject for consideration, each case requiring, as a rule, individual analysis and treatment. Suffice it to say that the Crocker-Wheeler Electric Company have furnished some of the largest and most comprehensive plants of this character and have accumulated a fund of information and data which they are always glad to place at the service of their customers.

It would be impossible to here discuss adequately the best methods to employ in the distribution of power electrically, as the conditions are so divirsified that no general rules can be laid down or advice given. The Crocker-Wheeler Electric Company should be pleased, however, to have prospective users of electric lights or power to consult with them or with any of their representative selling agents, tthat there may be placed at their disposal the results of long, varied and successful experience in this line.

While methods of application and use in individual cases may not be discussed, several of the features which make the Crocker-Wheeler apparatus superior to all others, may be made clear.

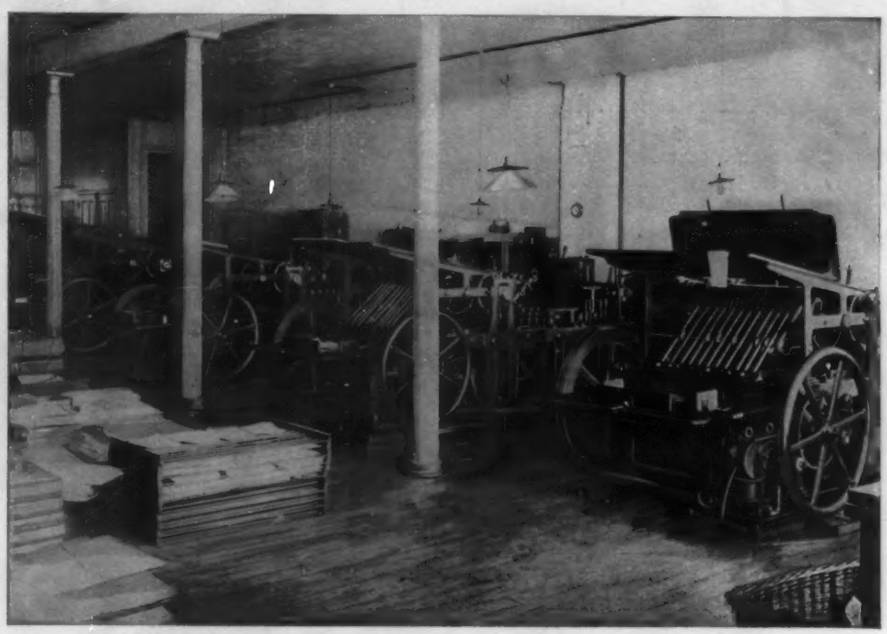
The Crocker-Wheeler dynamos and motors constitute machinery that is of the highest practical efficiency at full load and is capable of carrying its rated load continuously and considerable overloads for short periods comfortably. The mechanical and electrical design of the apparatus is such that it is exceptionally efficient through the entire range of load. As the average load on a motor is seldom more than one-half of its capacity, the matter of high efficiency at partial loads can not be too highly considered.

A Crocker-Wheeler motor was recently installed in place of one of another make, the parties using the motor having added in the meantime about 15 per cent more machinery. This motor was operated from a central station circuit through a meter, and since starting the new motor the meter bills have been greatly reduced, even with the added machinery..

Crocker-Wheeler apparatus costs little if any more than apparatus not so good and will soon save, in operating expenses and repairs, any difference in first cost. It is well and carefully manufactured and tough and will outlast 90 per cent of the apparatus on the market. In general this standard apparatus may be classed as of the bi-polar type for size 10 and under and of the multi-polar type for size 15 and over, special types being manufactured to suit special applications or purposes as occasion demands.

The pole pieces and fields of all apparatus of size 5 and over are made of soft cast-steel, and below size 5 of drop-forged soft iron. The matter of starting boxes, controllers and rheostats, as well as complete systems of motor control, have been given earnest attention, to the end that we are able to offer absolutely the best in these respective lines.

The illustrations presented herewith illustrate special applications of Crocker-Wheeler motors and when it is thought how few of the extensive manufacturing industries of the Pacific Coast have thus far made any effort toward eliminating the enormous losses of power due to belting and long lines of shafting, it is surprising that more such special applications are not to be seen. The illustrations are reproduced from photographs showing the use of Crocker-Wheeler motors in a rolling mill and in a press room, and, incidentally, it is not possible to find more trying duty for an electric motor to perform than these equipments which are new satisfactorily operating.



THE DIRECT DRIVING OF PRINTING PRESSES.

Detail dimensions, prints, capacities, speeds, weights and the lowest possible net prices will be furnished on application to the Abner Doble Co., San Francisco, who are the representative selling agents of the Crocker-Wheeler Electric Co., for the Pacific Coast.

A BABY ARC LAMP.

Among the novelties recently brought out is something new in the way of an enclosed carbon lamp giving 500 candle power and consuming 1¾ amperes at 100 volts. The lamp is made in two styles, for indoor service and water proof for outdoor use. The indoor type is handsomely finished in lacquered brass and has a length of about 20 inches over all. The carbons have a life of 150 hours and the lamps are made for either direct or alternating current service. Enough carbons are furnished with each lamp to last 1000 hours. These lamps are manufactured by the Brooks-Follis Electric Corporation, which will be pleased to correspond with any one desirous of further information or prices.

The Lay Press.

POPULAR REFLECTIONS OF THE CONDITIONS AND PROSPECTS OF ELECTRICAL ENGINEERING ON THF PACIFIC COAST.

New uses for electricity are constantly being discovered. A fish dealer runs a wire up through his counter and shoves it into a huge block of fish, and then labels it "Electric Fish." Any one curious enough to touch the fish with his fingers receives a very perceptible shock, which convinces him that the fish is correctly labled. Yesterday a local dealer in pickles, who has a dozen varieties in pans set on top of the different casks, had a wire run along, with a little branch of copper wire running into each pan. This charged the pan so that any one putting a finger in the pan to sample one received a smart shock. Just whether this was intended to keep people from sampling the pickles or as a joke on those who intended to do so, is not known; but after putting a finger near one pan no one attempted to touch another. If one took up the pan or put his hand on the pickles he received no noticeable shock, but the sensitive end of a finger put near a pickle received a rather unpleasant jar.—Portland Oregonian.

The assured and all but completed purchase of street railways constituting at least three-fourths of the facilities of the kind now possessed by Los Angeles, by a foreign syndicate with an outlay of capital in excess of $4,000,000, affords the best testimony to the solidity of this city and the confidence existing abroad in its future we have had in a long time. Such an investment would be particularly noticeable in, and be received with the warmest kind of self congratulation by any of the largest cities of the union. The magnitude of the amount establishes the high degree of the faith of the investors, and the fact that the latter are entire strangers to this city and are not swayed by any feeling of local pride or influenced by a desire to bolster up investments already made here, but that as a cold, independent business proposition, they selected out of the numberless enterprises competing for the favor of capital, many of which are offered by cities of greater influence and supposedly wider fame than Los Angeles, one in this city, cannot fail to yield abundant satisfaction to all interested in the progress of our community. The incident clearly shows that Los Angeles has been listed in the mind of the capitalistic world with the cities that are to win.—Los Angeles Herald.

Saturday afternoon the clouds hung heavy in the skies that seemed to reach but a short distance in any direction on the compass from Marysville. They lowered at about 4 o'clock, and the roar of thunder was terrific. So terrible in many instances as to alarm the native Californians. Then came the flashes of lightning. It was of the forked or chain variety, and its playful proximity was not desirable. Such thunder and lightning passed beyond the ken of the "oldest inhabitant," and the returns from points beyond the city are anxiously awaited. In this city the lightning did some damage to the telephone and electrical wires, and in one instance spent the awlfulness of its force on a tree and shed. This was at the residence of William Leech on E and Thirteenth streets. His wife and aughter were sitting on the back porch at a few minutes before 6 o'clock. They were not frightened at the frolicsome lightning until all at once there was a sound and a flash that was so near and so awful as to almost fasten them to the floor. Investigation then showed the lightning had torn a heavy door from a carriage house and splintered the 6x6 timbers on which it hinged. Parts of the door were scattered all over the yard. Nearer the house and not twenty feet from where they were sitting the bark was peeled off a limb of a big walnut tree, and a dozen or more small birds were killed and dropped to the ground. This performance is said to be the first of its kind on record in Marysville—Marysville (Cal.) Appeal.

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